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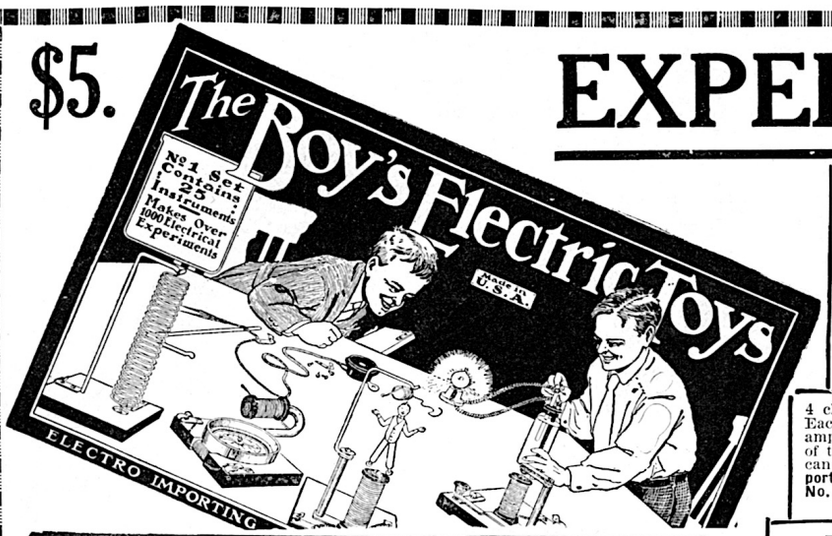
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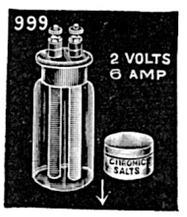

This is an ideal battery for electrical experimental work where a very powerful current is not required. This battery will light a 2 volt lamp for several hours on one charge; it will run a small toy motor surprisingly well; it will do small electroplating work; it is ideal for testing work; it gives a fairly steady current, **and as the zinc electrode can be pulled clear of the electrolyte, no materials are used when battery stands idle.**

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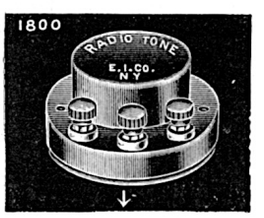

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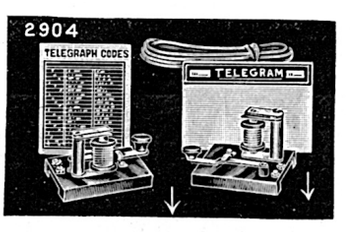

is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½ x 2½ x 2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back. **Price Complete as illustrated (TWO INSTRUMENTS).. $1.25**

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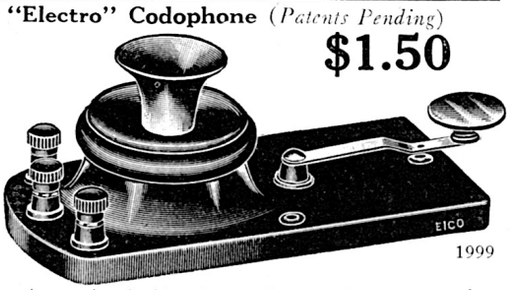

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The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver. The loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

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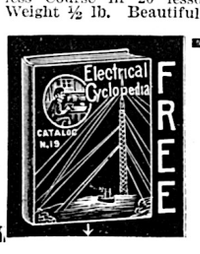

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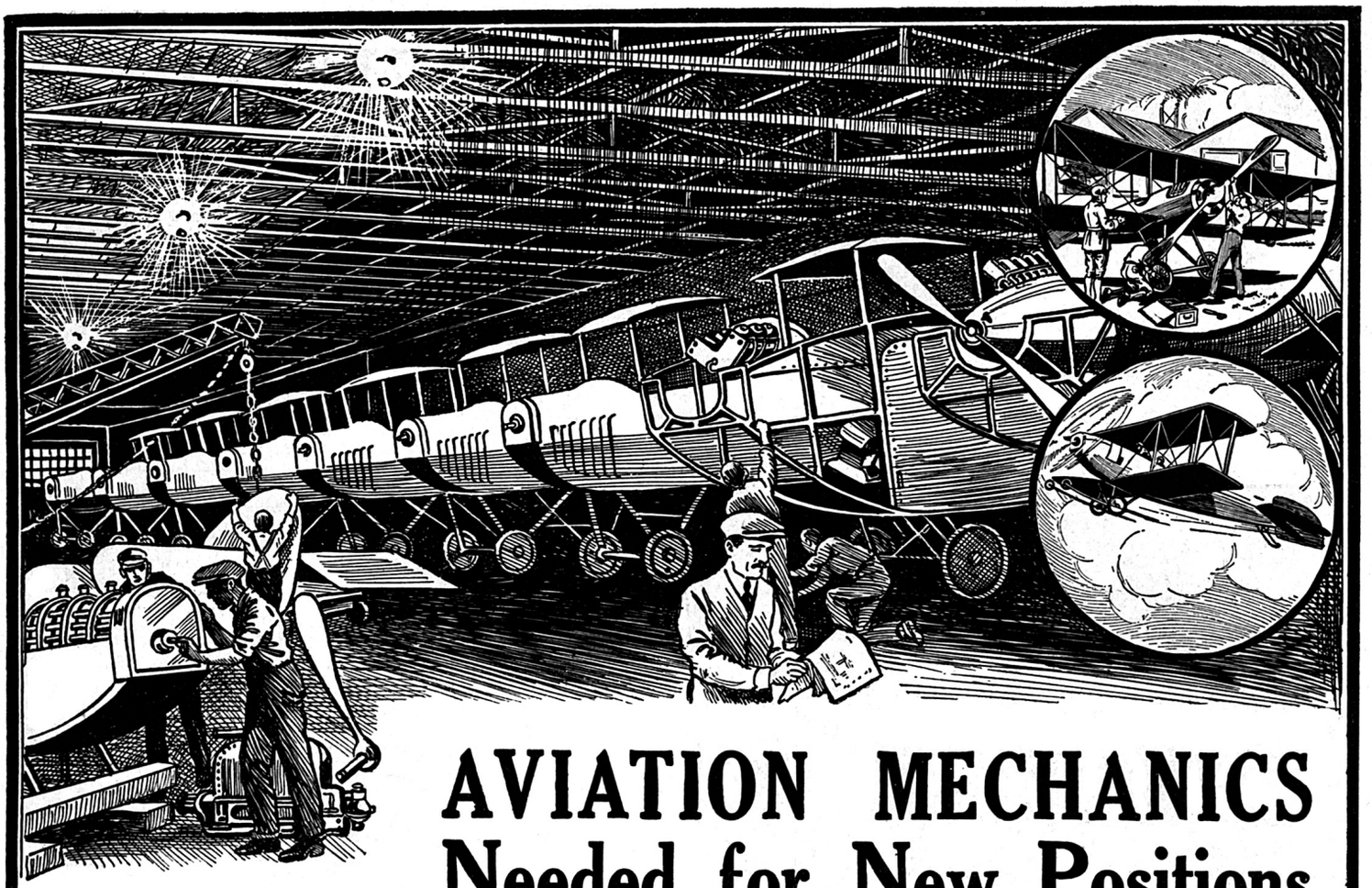

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"Twenty Years Ago"

THE following is an excerpt from a letter which reached me a short time ago. I quote one of the paragraphs verbatim:

"I am a widow with an only son. Jerome, who is an ardent reader of your splendid publication, which he has taken for over four years, is going into his twentieth year. For some time he has taken a correspondence course in electricity, and now he wants to enter an electrical school to learn the profession in a practical manner. While I know that he will make a success of it, I am somewhat troubled, as I, as well as his Uncle, think that the electrical field just now is very much overcrowded. The reason why I write to you is to have your honest opinion and what you think of the outlook in the electrical field. Is there much chance for the young man and is there a future for him? . . ."

Without knowing just what branch of electricity the young man is going to choose, our answer of necessity must be somewhat vague. Nevertheless, we have not the slightest hesitancy in stating that not only is the electrical field not overcrowded, but there exists now, and there will exist for years to come a great shortage of practical electrical men.

No field is as diversified as the electrical. Nowhere is there greater opportunity for the man who knows, for the man who specializes in *any* electrical line. As in every field of endeavor, it is primarily the knowledge of the man that counts. The field itself is secondary. But we earnestly believe that the man who has a general training in electricity has an open *Sesame* before him these days.

We are so busy and so engrost in our everyday work that we hardly ever stop to think how fast the world is growing and how tremendous the strides have been, all mainly due to the magic of the electric current.

Let us see just how the world looked twenty short years ago, before the young man in question was born. It will surprise us.

Twenty years ago, there were no electrical trains, no subways, which now whizz us daily to and from our work. Untold millions are invested in these enterprises and tens of thousands of people are engaged in the electrical end to operate these trains.

Twenty years ago, we were still burning our inefficient carbon lamps with their dull red light. Nobody thought of the brilliant tungsten lamps. Millions are invested in this industry alone, while thousands upon thousands of people are employed in it. What kind of light will we have twenty years hence? How many additional millions will be invested in a brand new lighting industry, and how many thousand workers will it employ?

Twenty years ago the X-Ray tube was just emerging from the laboratory to save untold human lives. Today the X-Ray industry is one of the most profitable ones, there being close to a thousand concerns manufacturing these wonderful tubes. And the X-Ray is still the great "X"—the unknown. We don't know to this day what these rays really are. What the next twenty years will bring to this field is impossible to forecast.

Twenty years ago there was no commercial nor amateur wireless telegraph, nor the wireless telephone. Can you imagine an ocean liner without its wireless today? And what of the countless millions invested in the wireless industry? And if the tens of thousands of wireless experts, near-experts and plain workers were quadrupled today, there would still be a dire shortage. And what impossible feats will "wireless" perform 20 years hence? Wireless *power transmission* alone will be an undreamt of huge industry. The mind staggers at the possibilities.

Twenty years ago there were no electric heating utensils. There were no electric flat-irons, no electric toasters, no electric ranges, no electric heating pads, no electric water heaters, etc. While today the electric heating industry is a very important one, and growing by leaps and bounds.

Twenty years ago there were no electric flashlights. Today it is a mammoth industry, with over 60 million dollars invested in it! Over 400,000 flashlights are turned out every working day in the U. S. alone!

Twenty years ago the ubiquitous electric dry battery—the common dry cell—was practically unknown. We still had our messy wet cells, which somehow or other never worked. Last year in the United States alone there were manufactured dry cells to the tune of over 40 million dollars! And every manufacturer is oversold for 1918! Aside from this the present dry cell is far from satisfactory.

Twenty years ago there were no electric baby incubators which now save thousands of lives every year. There were no vacuum cleaners, no radium, no transcontinental telephone, no slot telephone, no high-frequency machines, no spark plugs to make automobiles possible, no moving pictures, no automatic-electric block signals to save thousands of lives.

The list is as endless as are the prospects twenty years hence. Can anyone deny the wonderful future of electricity in view of such facts? H. GERNSBACK.

The **ELECTRICAL EXPERIMENTER** is publisht on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $1.50 a year in U. S. and possessions. Canada and foreign countries, $2.00 a year. U. S. coin as well as U. S. stamps accepted (no foreign coins or stamps). Single copies, 15 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., INC. If you change your address notify us promptly, in order that copies are not miscarried or lost. **A green wrapper indicates expiration. No copies sent after expiration.**

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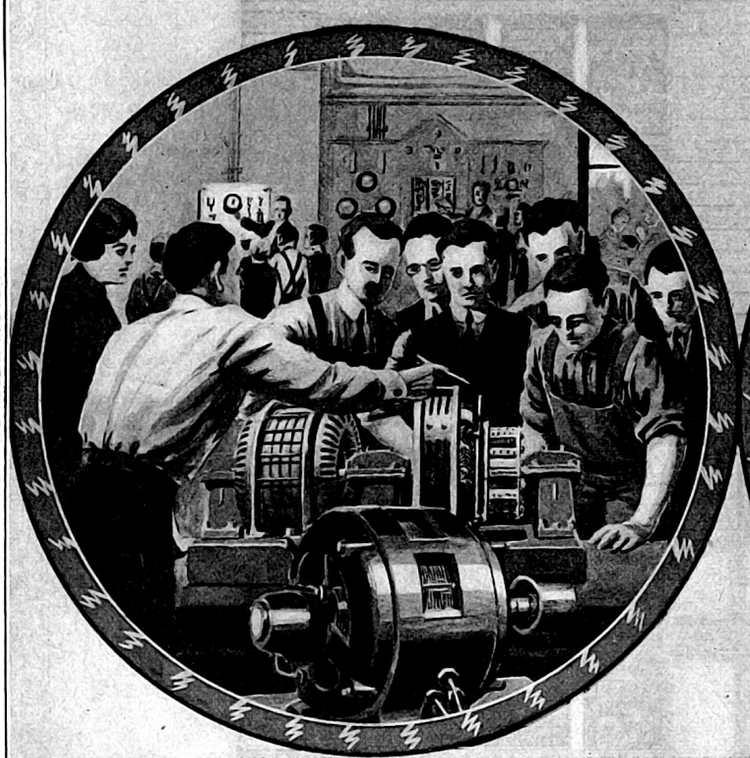

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H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 60 April, 1918 Number 12

Seaplane Radios Trawlers and Destroys U-Boat

ONE of the latest official stories from London describes the wonderful, almost uncanny, hawk-like qualities of the modern radio-equipt seaplane. In this instance the seaplane was flying along on patrol duty when suddenly it spotted a Teuton "unterseaboat" resting peacefully on the sea bed.

At once the seaplane officer sent out a radio call to a destroyer and her fleet of trawlers ten miles away. The aerial fighting craft never took its eagle eyes off the enemy submarine, but continued to circle around and around, making sure that it did not sneak away, as these sly craft are often wont to do. Shortly the destroyer and trawlers arrived on the scene ready for action under the direction of the seaplane. The trawlers got out their sweeps and began steaming toward each other. As they met their wires engaged the bow and stern of the submarine and began to pass under the submarine. Then the submarine released two mines which the crews of the trawlers ignored with the reflection: "Her eggs can wait a minute."

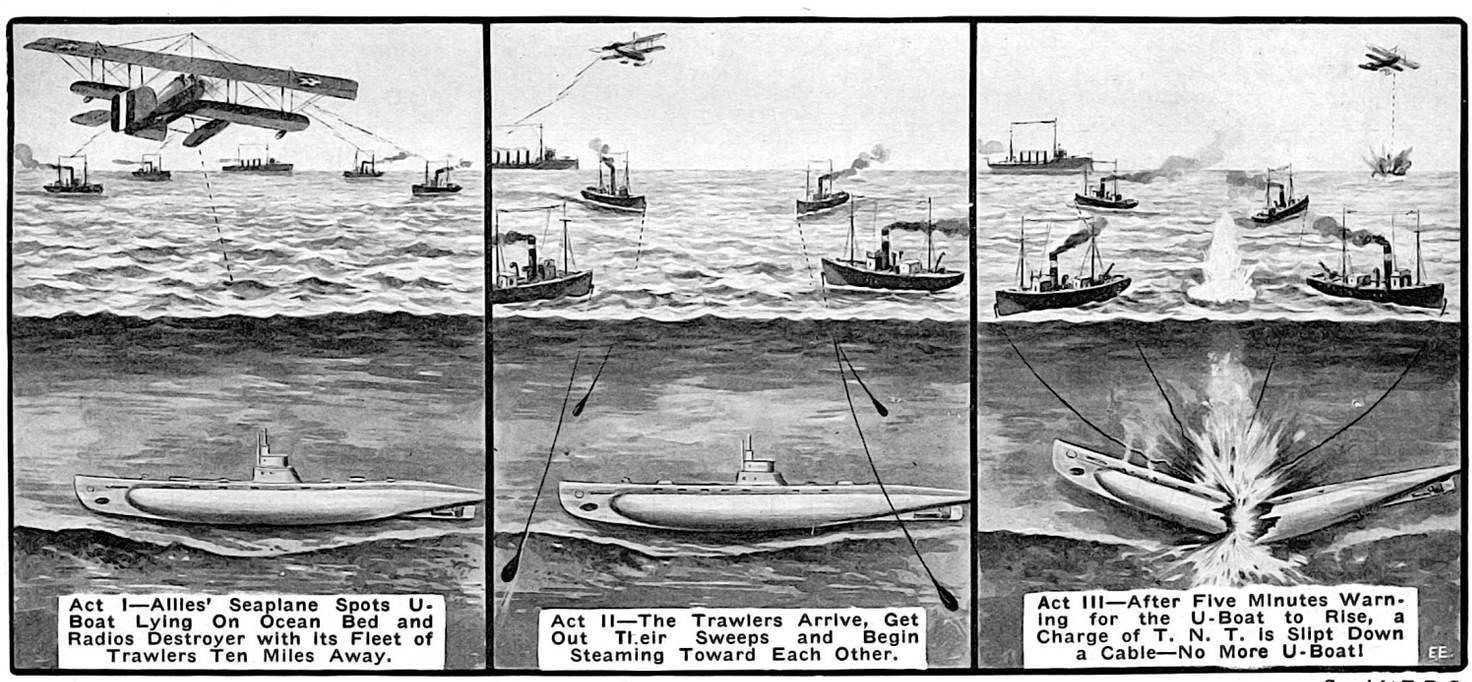
Then the trawlers crost and held the wire and let it slide down to the submarine's hull. An ominous silence rested on the strange stage setting for a few moments—moments that seemed like hours. Then the distant-like deep boom and two gigantic, foaming gray mounds of water presently muffled the explosion. The wires about the submarine snapt in the middle and the crews coiled them up. Meanwhile the seaplane circled around a patch of oil that came to the surface and then notified the trawlers that the submarine was destroyed.

The aerial observer then slipt a band of cartridges into his gun and sped off after the mines floating in the tide to burst them with rapid firing. The first mine sank punctured and the second exploded as the bullets reached it.

The Germans are loath to divulge U-boat casualties to anyone, even their own people, and especially among their naval crews. The Allies are slowly but surely curtailing the activities of enemy submarines. This is so for several reasons, chief among which is the fact that the leading scientific minds among the Allied councils are at work on anti-submarine devices and schemes.

The Americans have brought to bear on this problem a vast array of scientific talent—more than the average man would possibly ever suspect. Secretary Daniels of the U. S. Navy Department has recently stated that a new anti-submarine device in the form of a "locater" is being tested out in practise and giving very favorable results.

One Yankee inventor has perfected a sound-wave "sub." locating scheme, which has proved of such a meritorious nature that the *Naval Consulting Board* has taken it up in earnest. Publicity cannot be given to this invention now, of course, but without mentioning harmful details it may be said that the idea is to send thru the water a powerful sound wave, as by means of a Fessenden sub-sea oscillator and then to intercept the reflected wave or echo. By


Act I—Allies' Seaplane Spots U-Boat Lying On Ocean Bed and Radios Destroyer with its Fleet of Trawlers Ten Miles Away.
Act II—The Trawlers Arrive, Get Out Their Sweeps and Begin Steaming Toward Each Other.
Act III—After Five Minutes Warning for the U-Boat to Rise, a Charge of T. N. T. is Slipt Down a Cable—No More U-Boat!
EE.

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RAILROAD TRAINING GIRLS AS TRAIN DISPATCHERS.

One of the large eastern railroads has opened a building in Philadelphia, where a staff of competent teachers will instruct hundreds of girls in the art of train dispatching.

The picture shows one of the girl students seated at an electric switchboard in the school. On the table is a complete miniature railroad, operated by electricity with switches, signals, semaphores, etc., by means of which the students are taught the duties of a dispatcher.

The complete miniature electric railway would, in its completeness, tickle the boy Edison to his heart's content. It works just like the big railroads—only no one is killed or have their leg cut off, should the fair train dispatcher make a mistake and transpose a freight and a passenger train at the wrong moment. But she is reprimanded—never fear. That's what the school is for—to teach the profession and teach it right, for railroading is one of the most, if not the most exacting of vocations.

And so it happens that we see few errors, even with beginners as we watch the deft fingers of the beskirted railroad students, as they push the buttons that cause the miniature semaphore lamps to flash red, then green—stopping trains in certain blocks and starting them again when the block ahead shows "clear."

Hats off to the "Ladies of the Rail."

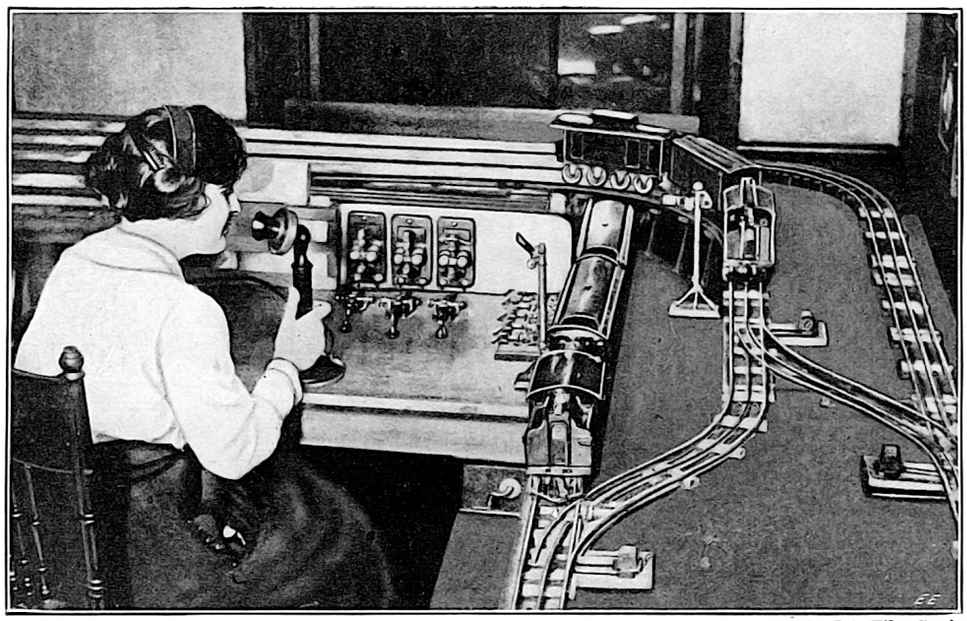

Photo by Int. Film Service

Here We Have a Glimpse of Miss America Learning to "Do Her Bit"—Students Are Taught Railroad Train Dispatching With a Complete Miniature Electric Railway Like That Shown.

"METERWOMAN" TO SEE YOU, SIR!

Women will be employed by the Rochester Railway and Light Company as meter readers, beginning next month. The step has been taken to relieve men for military service and for urgent work in other lines. The women will be given a preliminary course in meter reading.

Frederick W. Fisher, employment manager, stated that the women will wear an official badge of identification. Altho it will in many instances be necessary for the "meterwomen" to clamber into unpleasant positions, they will not be required to wear overalls.

WIRELESS PLANT IS SEIZED.

A wireless plant thought to have a radius of several hundred miles was seized recently by Sheriff Applegate at Timber, a small community about 20 miles from the Oregon coast. The plant, which was rather well concealed, was found at the home of J. E. Jacobson, who is ticket agent and operator for the Southern Pacific R. R.

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measuring the time required for the reception of the echo, and several other factors, the exact position distance of the "sub." can be ascertained on special, finely calibrated instruments.

The Germans are, according to one writer who resided in their country not so long ago, making use of a clever sound wave stunt for locating enemy ships without using the periscope. This scheme involves nothing more or less than applying the principles of triangulation, well known to every student of civil engineering and surveyors, to sound wave propagation, reflection and interception. One of the U-boats might, for instance, send out a powerful sound wave from an under-water oscillator; this wave, especially if concentrated, would be reflected upon striking the hull of a steamer and at an angle. By underwater sound wave telegraphy two or three U-boats could quickly check up the angles of reflection and determine the speed, as well as the location of the steamer or warship, and without once showing their periscopes. This may be the answer to the *Tuscania* riddle—it is said that no U-boat was sighted. Another way of firing torpedoes accurately without taking sightings thru the periscope was described in the July, 1917, issue of the ELECTRICAL EXPERIMENTER.

A Swiss electrical engineer, employed for the last ten months at the electrical works at Kiel and who has recently returned to Geneva, says that the Germans are making every effort to conceal their submarine losses, especially from the navy, because of increased difficulty in mustering crews. He estimates the Germans lost 30 per cent. of their submarines during the time that he was at Kiel.

"I saw a score of submarines lined up in the canal undergoing repairs," he said. "They had been hit by depth bombs, which the Germans seem to fear greatly."

The engineer added that there had been two serious mutinies at Kiel during 1917.

WHAT IS T. N. T?

Tri-nitro-toluol, or tri-nitro-toluene, or T. N. T. is a white solid which is easily made and which is safer to use than many other explosives. Chemically it is $CH_3 C_6 H_2 (NO_2)_3$. It is made from toluol and nitric acid. The toluol is obtained as a by-product in the coke industry. There is not enough toluol prepared in the United States to supply its present needs. The tar and illuminating gas of the city gas-works contain toluol. By making certain changes in equipment the toluol could be saved. Toluol in gas gives illuminating power, but if gas mantles are used its absence will not be mist. It is of no value in the gas used for heat. It has been estimated that enough toluol is burned in illuminating gas in the United States in *one day* to make T. N. T. for 150,000 3-inch shells. Three hundred pounds of T. N. T. are used in a single torpedo.

CHICAGO HAS FIRST ELECTRIC FIRE BOATS.

The first electrically propelled fire boats are in service in the City of Chicago. They are 125 feet long and can deliver 9,000 gallons of water per minute at a pressure of 150 pounds to the square inch.

ECUADOR AND PERU FAVOR AMERICAN ELECTRICAL GOODS.

America's opportunity of increasing its sales of electrical goods in Ecuador and Peru during the absence of German competition is pointed out in a report made public recently by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Before the war this trade was divided between Germany and the United States, the advantage being with the American manufacturer. The Government's report is concerned with the market as it exists today and the opportunities it offers for the future.

Copies of "Electrical Goods in Ecuador and Peru," Special Agents' Series No. 154, can be purchased at the nominal price of 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or co-operative offices of the Bureau of Foreign and Domestic Commerce.

HIGHEST TELEPHONE LINE IN THE WORLD IN COLORADO.

Engineers of the Mountain States Telephone & Telegraph Co., have installed what they believe to be the highest telephone service line in the world. On the Denver-Leadville toll route the company has constructed the section of the line that crosses Argentine Pass at an altitude of 13,200 feet. The newly-built section is only one and three-tenths miles in length, and it is estimated that the cost of construction was more than $12,000.

BACK NUMBERS!—Many readers desire to obtain back numbers of this Journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of the Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each; over one year old, 35 cents each.

Search-light "Sub" Destroyer for Ships

By H. Winfield Secor

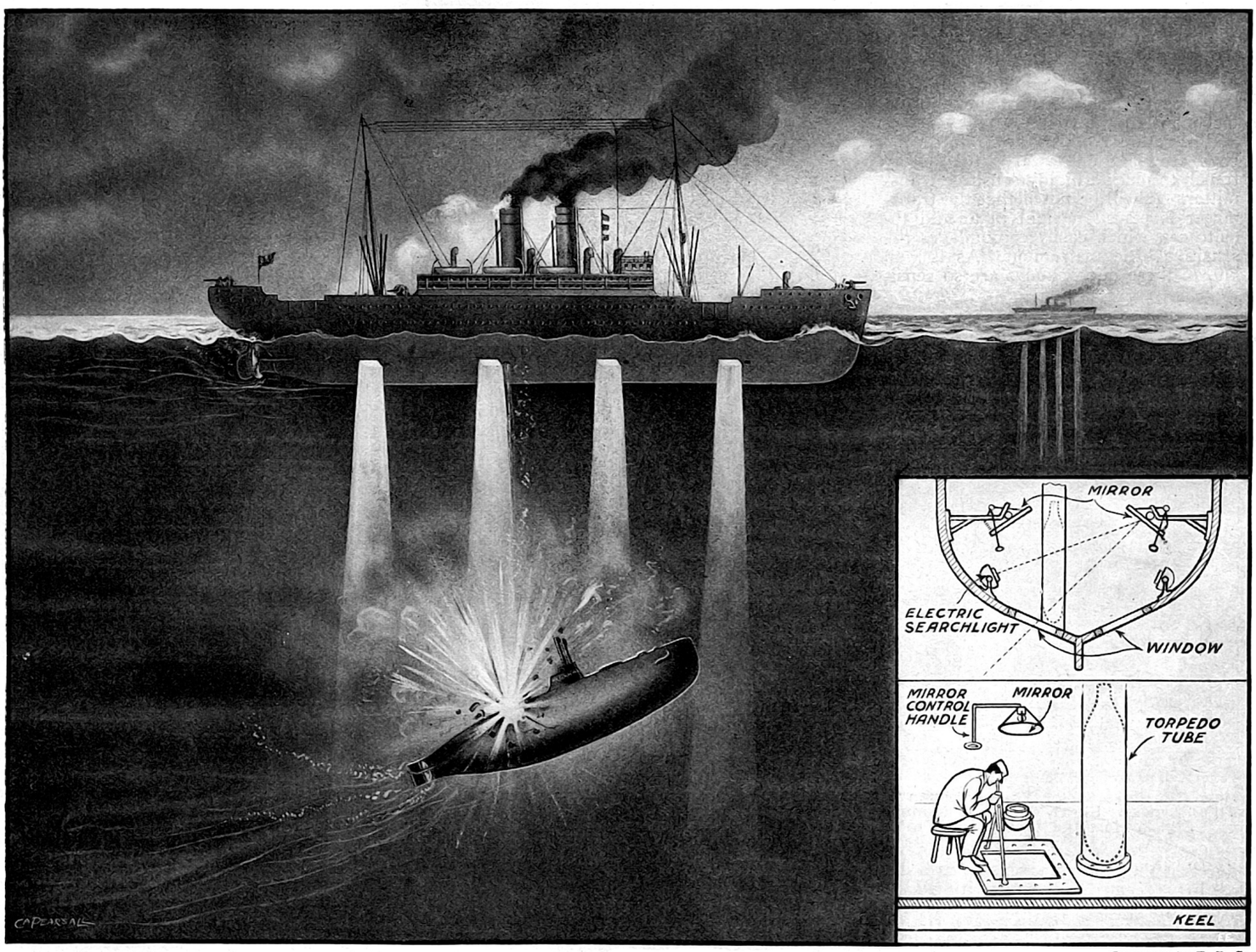
IT has happened now and then that a merchant vessel has past directly over an enemy submarine without knowing it. Likewise enemy submarines have dived under steamships for one reason or another—perhaps to escape being rammed, or again to get a better chance to torpedo the unsuspecting vessel. Now imagine what would happen if, just when the ship was over the sub-sea craft, it suddenly turned on a battery of powerful under-water search-light projectors, as shown in the illustration!

moved off the spot—a matter of a few seconds. Also, the lower part of the hull of ships so equipt could be strengthened and double-bottomed to stand the extra strain. Besides, why have the depth bombs detonate so quickly? Considering that the target is, under these conditons, fairly sure of being hit, why not use magnetic torpedoes—each torpedo to be provided with a powerful electro-magnet, so that when it reaches the "sub's" steel hull it will be attracted and held. Then, with suitable time fuses attached (or else by providing them

Sperry search-light, capable of developing over a billion candle-power in one concentrated beam.

This interesting scheme of combating submarines has been patented by an Illinois inventor, Mr. George W. Keister. In his patent specifications, among other things, he says:

"The present invention relates to a device for torpedoing and destroying submerged objects such as submarines, and has for its object to provide a device of this character which embodies novel features of construc-



Copyright by E. P. Co

A Recent Invention for Destroying Enemy Submarines, Which Involves the Use of One or More Powerful Electric Searchlights, the Beams of Which Are Projected Thru the Glass Windows in the Bottom of the Vessel's Hull. When a Submarine Is Spotted, the Observer at Once Discharges a Depth Bomb, Which, if Fitted With a Strong Electro-Magnet, Will Attach Itself to the "Sub's" Hull, and Explode Later When the Time-Fuse Acts. This Allows the Vessel Time to Get Away from the Spot.

As soon as the observer stationed inside the ship's hull sees a black hulk, he discharged a torpedo or depth bomb with every chance of hitting its mark. Considering that the projectiles would come fairly close or right on the target, they would not have to be loaded as heavily as the depth bombs ordinarily used, with the consequence that the vessel discharging them would not be in such danger of self-destruction or injury, as are the present destroyers and other craft. By means of time fuses suitably applied the depth bombs need not detonate until the vessel had

with an electric diafram depth-gage detonator, as described in the January, 1918, isue of the ELECTRICAL EXPERIMENTER), the U-boat would continue on its way, suspecting nothing perhaps, unless it should have been the slight bump when the magnetic depth bomb "took hold," when suddenly—well, it would be all over for the Hun sub-sea sailors in less time than it takes to tell about it.

It is possible to see a distance of 75 to 100 feet with modern high power electric search-lights under water, especially with such intensely powerful projectors as the

tion, whereby a submarine, even tho it may be submerged to a considerable depth, can be located from a vessel directly above the same and a torpedo projected with accuracy in the direction of the submarine.

"Further objects of the invention are to provide a device for destroying submarines which can be mounted without difficulty or great expense upon any small vessel of a sufficient size to carry a torpedo tube, which can be controlled by a single operator. (providing only one sub-sea searchlight is used), and which will make it easy to locate

(*Continued on page* 865)

The Dictograph in the Trenches

IN our November, 1917, issue Mr. H. Gernsback showed graphically how the microphone could be used for trench warfare, and we showed several applications how it was to be accomplished. While the article was not official in any way and only showed the application as it existed in our minds, we are now happy to show actual photographs of the same idea, showing that the idea is now in actual use on the front, the strange part being that the several applications are exactly as shown by us in our article, which like many similar ones was only imaginary, we having no official information of any kind that the microphone was being used for such purposes.

Our photographs show the dictograph at the front, and how our boys "over there" use the instrument to detect plans of the enemy.

Illustration No. 1 shows one of the boys crawling up towards the enemy trench to place a highly sensitive transmitter. It will be noted that the transmitter is placed upright in an old tomato can which easily camouflages the sensitive little instrument. As is well known these microphones are so sensitive that they detect a whisper at a distance of fifty feet. The sensitivity too is increased a great deal if the wind blows towards the microphone.

Fig. 2 shows how one of the microphones is placed near the enemy trench in a sort of dug-out, but little ground separating the microphone from the trench. This is right under the enemy's parapet.

In Fig. 3 a trench receiving station is clearly shown. At this station the intelligence is received by one or more operators, usually one listening, the other writing down whatever talk is picked up.

It goes without saying that the successful placing of these detectaphones as well as the laying of the wire, which operations are always under direct fire of the enemy, is one of the most dangerous and difficult undertakings in modern warfare. It is a task allowed only to a man of iron nerve, and it takes much courage and good judgment not to blunder.

During the night very often the presence of a man is detected, and it then becomes necessary for him to lie perfectly still for perhaps hours at a time, as the slightest movement would draw machine gun or sharp rifle fire at once. When finally the man in "no man's land" retraces his course, he must do so very slowly and cautiously, going backwards at the rate of fractions of an inch at a time, irrespective of the fact that it may be freezing or that the rain may come down in torrents. However, this is only one of the disagreeable fortunes of war, and our boys do the work as cheerfully as they do it efficiently.

Photos Western Newspaper Union

How Our Boys "Over There" Listen in for Fritz's Secret Confabs. A Super-Sensitive Telephone—Known as a "Dictograph"—Is Used For This Purpose. Fig. 1, Shows a "Sammie" Crawling Up Near An Enemy Trench to "Place" a Camouflaged Microphone (in a Tomato Can); Fig. 2, How the Dictograph Transmitter is Placed in a Dug-Out Near an Enemy Trench; Fig. 3, A Trench "Listening Station."

WHITE HOUSE ELECTRICITY.

The White House at Washington is said to have the most intricate and complete electrical system installed in any building in the United States. There are in the mansion nearly 170 miles of wires, providing for 3,000 incandescent lights, a bell system, and a private telephone system for the President and his family exclusively.

NEW METHOD OF MAKING LEYDEN JARS AND CONDENSERS.

Long ago the tinfoil type of Leyden jar and condenser for wireless telegraphy and other purposes passed into oblivion, and in its place settled the copper-plated type. A new method of producing metal-coated glass for such purposes is described in *Glashütte,* which, it appears, is a variation of the Schoop process. According to this method the surface of the glass is heated until it just begins to soften and the surface is then sprayed with finely divided metallic powders. The metallic particles are thus driven into the surface of the glass and a very durable metallic coating ensues. It is stated that when the under surface of the glass flask is treated with copper or aluminum in this way the water can be raised to boiling point in three-quarters of the time that would otherwise be necessary, and, in addition, the vessel is much less liable to crack. One would imagine that this process would have useful applications for treatment of glass reflectors for lighting purposes.

The instrument known as the dictograph employs a super-sensitive microphone connected with a telephone receiver and battery. The microphone converts the sound waves into corresponding electrical currents variations, which operate the receiver.

INVENTOR CALLED BY U. S. TO FINISH U-BOAT DEVICE.

Experimenting for a year with an invention aiming at the destruction of submarines, Prof. Harvey C. Hayes, head of the physics department of Swarthmore College, has been so successful that he has received a call from the United States Government to enter the national service. He refused to discuss particulars of his new venture adding that he has been forbidden to disclosed the location of the laboratory where he is to continue his research work.

Professor Hayes will be joined by five other physicists from the best universities and laboratories in the country in the Government research work. They commenced work on January 1. Professor Hayes expects to be engaged in this service for a year at least, and it is unlikely that he will return to Swarthmore at the opening of the next term in September. His family will accompany him to the site of the laboratory.

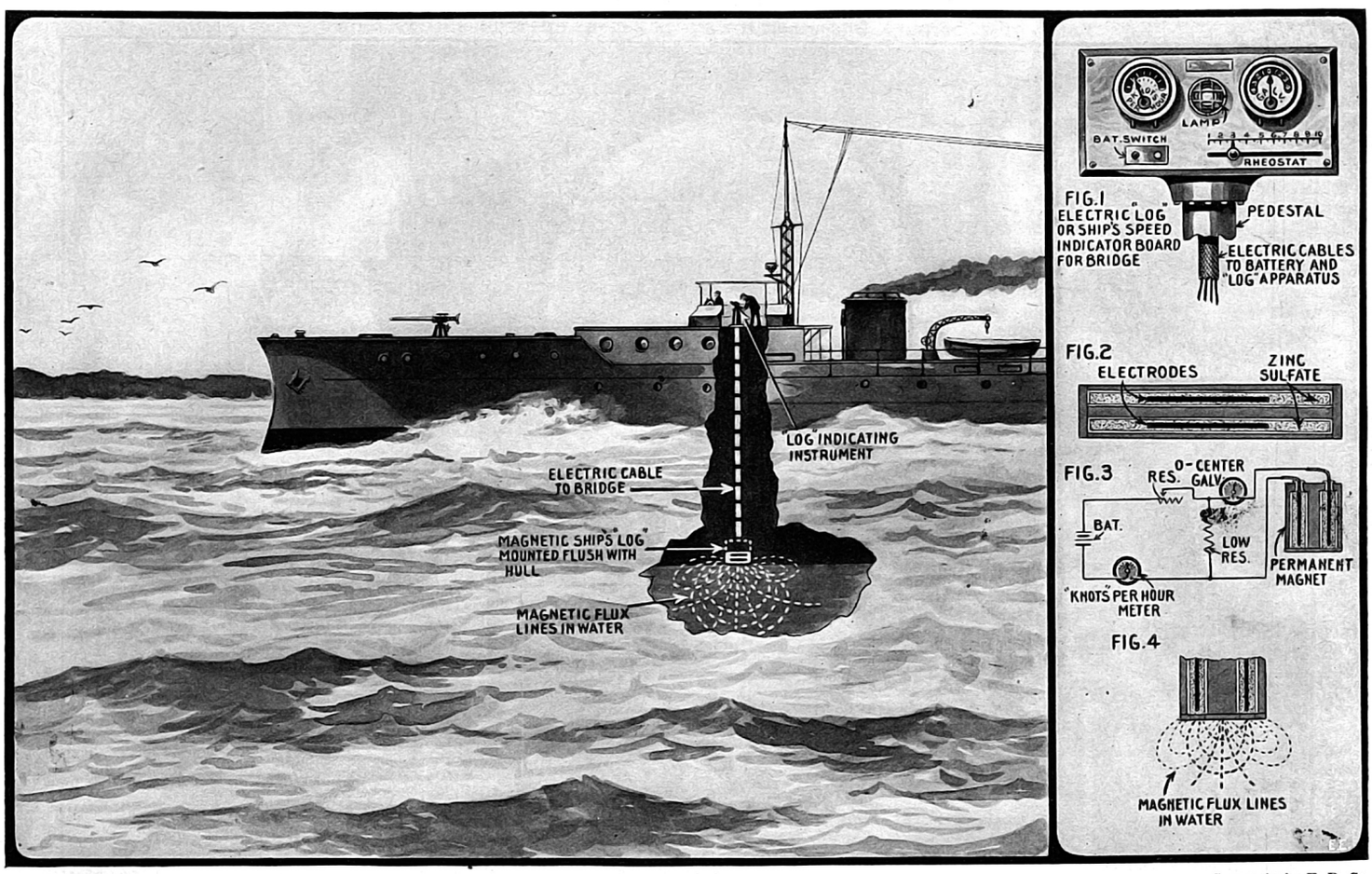
Professor Hayes was in his fourth year as a member of the faculty of Swarthmore College. Previous to his service in the physics department he was an instructor in research work at Harvard, where he took his doctor's degree. The vacancy caused by Professor Hayes' withdrawal will be filled by W. O. Sawtelle, of Harvard.

"Electro-Magnetic Log" that Measures Ship's Speed

TALK to any old-time jack tar or sailorman as to how they measure the velocity or speed of a ship when under way, and he will cut loose with a long tirade on the various merits and demerits of the immortal *taffrail log*—famed in song and story the world around. For the taffrail, be it known, gentle reader, is the hindermost deck rail on a ship, while the *log line* is the rope or cable which is heaved over said rail and into the briny billows below whenever the cocky commodore wishes to know how many knots the mechanisms used extensively on large and small vessels leave something to be desired. They are not as simple or as accurate as they should be.

Realizing these facts, two Boston inventors—Messrs. Smith and Slepian—have worked out a very ingenious and extremely simple electro-magnetic ship's log which is illustrated herewith, both in detail and applied to a ship. It's principal feature is that it does away with all dangling thingmabobs suspended from ropes or cables, and which devices, owing to this fact, are exposed to the water; Fig. 2 is a longitudinal section of the magnetic device, while Fig. 3 is a wiring diagram of the electrical connections to the meter calibrated to read *knots per hour,* and Fig. 4 shows the distribution of the magnetic flux and the direction of the induced E. M. F.

In the illustrated embodiment of the invention the magnetic flux is furnished by a permanent magnet, having a middle pole N and two side poles S. The magnet poles are long and narrow. *The magnet is arranged permanently in the ship's bottom*



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Every Yachtsman and Sailor Knows What the "Log Line" Is—It Measures the Speed of a Vessel Thru the Water by means of a Spinning Propeller Attached to Its Lower Extremity, Which Connects With a Dial Device at the Taffrail. Errors Are Liable at Any Time, Especially When the Observer Is Inexperienced. Here's the Latest—a pure "Electrical Log" Which Is as Rugged as It Is Simple. It has no moving Parts and Is Built Flush With the Hull.

good ship is making. And how does the faithful mate take the *log?* Well, it's this way, fellow land-lubbers:

As aforementioned, the *log line* is thrown over the taffrail and into the water. At the lower extremity of the line there is secured a propeller-like device which spins around at a speed proportional to the speed which the ship is making thru the water. The revolutions which the little propeller makes are transmitted to the deck rail by virtue of a flexible shaft, which connects with a dial and indicating arrangement, whereby it becomes readily possible, with the aid of a stop-watch, or by other means, to determine how many *revolutions per minute* the log propeller is revolving at. By referring to tables and other data provided for the purpose, it thus becomes possible to find out how many knots you are making. But this is a round-about way of doing it. Even the new electrical log always subject to more or less error. This new electro-magnetic log is a fixture, once installed on a vessel; there are no protruding parts to be knocked off or damaged, and the indicating instrument reads off the ship's speed directly and accurately in *knots or miles per hour.*

Here is the way in which the new electro-magnetic ship's log works: A magnet is placed on the ship's bottom so that the magnetic flux passes thru the sea water. The magnetic flux traveling with the ship thru the water generates a difference of electric potential in the water directly proportional to the velocity of the ship. These differences of electric potential are measured and from them the speed of the ship is determined.

In the drawings which illustrate the detailed construction of the invention, Fig. 1 is a perspective view of the inclosed magnet and electrodes, the lower face of which is so that the lower face of the magnet is next to the water. The magnet is insulated from the ship's bottom and the lower face of the magnet is insulated from the water by a plate of insulating material. The ends of the magnets are closed by plates of non-magnetic material. In the cavities and between the poles of the magnet are located two electrodes of amalgamated zinc. The cavities around the zinc electrodes are packed with zinc sulfat and the cavities are lined with insulated linings. In the insulating plate are plates or windows of porous earthenware thru which the water can seep, to form an electrical connection between the sea water and the zinc electrodes in the cavities.

While the porous earthenware windows allow an electrical connection thru them, they do prevent any considerable diffusion thru them of the zinc sulfat so that the

(*Continued on page* 863)

At War With the Invisible

By R. and G. WINTHROP

(CONCLUSION)

"WE must get hold of Professor Firman right away," I declared, finally. "He should understand this. Go tell your father, Ava, while I locate the professor."

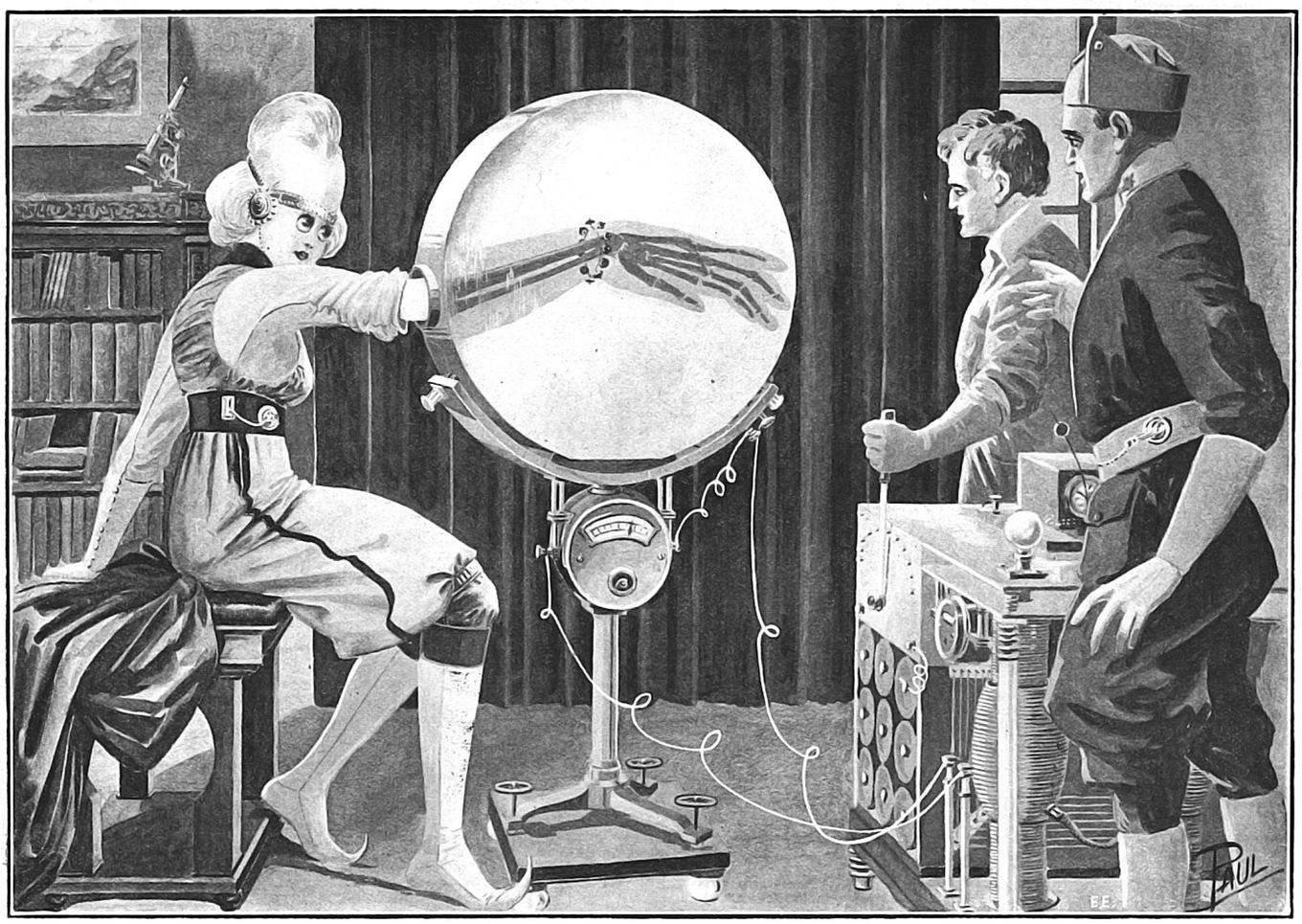
With the pocket 'phone I reached Firman in a few moments. Late as it was, his laboratory at Columbia University still claimed him, his energetic brain busy with the problem that held the universe. To my tremendous importance of what had occurred

Another obstacle presented itself when we reached Firman's laboratory. To secure the privacy he needed for his work he had double-barred all doors leading to his rooms, and, of course, had forgotten my promised visit as soon as the 'phone was out of his hand. But such trifles were not to stop me on this night.

in picturesque phrases how much longer the inefficient police were going to allow drunken aerists to go around smashing busy people's windows.

"It's all right, Firman," I assured him. "This isn't an accident. It's Elvan."

I was brimming over with suppressed excitement, hope and happiness. The sight of his strong face, its massive features outlined clearly in the moonlight, heightened



". . . Arranging His Apparatus, Professor Firman Placed Ava's Arm Before the Helium-Planoscope Screen and Directed a Powerful Helium Ray Upon It. . . . An Outline of the Flesh and Bones Greatly Enlarged Was Visible, and Around the Wrist Was a Circlet of Tiny and Heretofore Invisible Bells."

demand that he come at once he turned a deaf ear. Nothing could take him from his work. Fervently I cursed his stubbornness, but the difficulty was a minor one. If the mountain would not come to us we could readily go to the mountain. Telling him to expect me in a few minutes, I hastily replaced my 'phone and turned to greet President Venasarol, who was approaching, his mouth open in bewilderment at the excited account his daughter was giving him of my discovery. I added a few words, grasped Ava's arm and hastened off with her, leaving the Honorable Peros still dazed and only half comprehending the

Leaving Ava to await my return on the roof, I sank slowly to the upper story of Schermerhorn Hall, where several lighted windows showed the presence of workers. I selected the largest window on the supposition that it must be Firman's, and brought the nose of the plane against it with just enough force to send the glass crashing to the floor inside the room. A high-pitched voice, lifted in bitterly complaining profanity, satisfied me that I had struck the right one. No one could swear like Firman!

In another moment he appeared at the opening, peering out angrily and inquiring

the feeling of confidence that had possest me from the moment I saw Ava. Firman was the mental giant of this scientific age. With the help I could give him I knew we would solve the deadly riddle of invisible attack on our world and save it from destruction.

"Elvan!" his shrill voice—which always startled those who met him for the first time by its incongruity with his great bulk—rose still higher in surprise. "You! Well, what in hell do you want to smash my window for?"

"What in hell do you want to bar all your doors for?" I retorted. "I had to get

* This is a principle of physics not generally known. We cannot make a perfect mirror, but if we could, the mirror would be "invisible." Any object that is not primarily luminous in itself is seen by scattered reflection. If a surface was made so as to be perfectly reflecting, then all the light that fell upon it would be reflected, and this reflected light would reveal to the eye the source of the light before reflection. The reflecting surface itself would not be visible This phenomenon is known technically as "specular reflection." The reason we see polished surfaces is because of the imperfect reflection from such objects, the light being reflected in various directions.

in somewhere. Don't waste time arguing, but hurry around and open the doors. I have something tremendously important to show you."

I could hear him muttering unfavorable comments on importunate friends in general and me in particular, as he left the window, while I hurried back to Ava. A few moments later the three of us were seated around a table piled high with instruments and jars of substances. Firman pushed them aside with an impatient gesture.

"All worthless," he replied, briefly, in answer to my inquiring glance. "Not a single clue."

I smiled at him with an encouragement hardly yet justified. "The clue is here," I said, and pointed to Ava's wrist.

SYNOPSIS—PART I. This gripping scientific story deals with a "War of the Worlds"—an inter-planetarian struggle for supremacy—the scenes of which are laid in the year 2011. The planet Mars, with all her super-intellectualism, has made war upon all the planets. The hero is a special war correspondent of a New York newspaper, who, while detailed to the reception in Paris of the War Commission from Venus, becomes enamored with the beautiful daughter of the president of the visiting commission—the Honorable Peros Venasarol. She possesses a most remarkable bracelet—which is not only invisible but contains a set of tiny bells. The hero notes this bracelet carefully, for it apparently is something beyond earthly understanding. Suddenly the correspondent is summoned back to New York by his editor—he flies across the Atlantic over night. Philadelphia and London had been wiped off the face of the earth—swallowed up. Did an earthquake do it? Were the Martian 'planes getting thru the earth's air patrol fleet—and, even so, why didn't the selenoid towers indicate their approach?

As quickly as I could I gave him all the facts that we knew. Before I had finished he was already bending over Ava's arm, his black eyes sparkling with eagerness, his lips pursed beneath the large, aquiline nose that marked his ancestry. Deftly his fingers past over and around the invisible bracelet. Murmurs of surprise, commendation and pleasure came from him as his penetrating mind grasped the properties of the strange ornament. Finally he sat back, a peculiar smile of satisfaction lighting up his expressive face.

"Extraordinarily clever," he declared approvingly, "but simple." He paused. "Yes, simple—quite simple."

I bent over the invisible wonder with him. "What is it?" I asked.

"Nothing more than a system of mirrors." His hand toyed with the circlet on Ava's arm. "The inventor has merely made use of the principles of reflection and refraction of light. Each of these facets is a tiny mirror of some substances I don't know yet, but it must be something that reflects the light corpuscles with absolutely no *diffused* rays. *That makes the mirror invisible in itself.* (See note foot of page 818.) Furthermore he has joined these miniature reflectors to each other at such angles that a ray of light, striking upon any one, is bent from mirror to mirror until it emerges on the reverse side, at a point directly perpendicular to its point of entrance. Here is the idea, roughly—"

He drew a sheet of paper to him and rapidly sketched a circle with a series of points which he labeled *a, b, c, d, e, f, m, n, o, p, r, s.*

"You understand, of course, that I have indicated here merely the surface mirrors. Between each two of these is probably a series of double refraction surfaces to receive any rays that might otherwise be deflected to the observer's eye. But, generally speaking, this is what happens: The light from any object, as, for instance, the young lady's arm, strikes upon *m* and is reflected through *f, e, d, c, b* or *n, o, p, r, s* (depending upon the angle at which it enters) emerging at *a,* exactly opposite. To our eyes, unable to perceive the intermediating surfaces, *the light seems to come directly from the arm!"*

He paused, glanced swiftly from one to the other, as tho keen to see whether we were following his exposition, and then went on with increased emphasis: "You see the result! *The bells, under their remarkable covering, are entirely invisible!* The same thing happens from any other point. Looking at *b,* the light from the object at *n* would seem to be coming in a straight line; from *s* we would see the object at *f,* and so on. It is all very simple ——" He ended with one of his queer, dry smiles—— " —— after some one else has worked it out for us!"

I drew a deep breath in admiration of the startling ingenuity that had conceived this strange object and the acumen that had penetrated the mystery.

The "May" Number

Well, Friends, we sure have procured some mighty interesting articles for the "May" number of the ELECTRICAL EXPERIMENTER, *if we do say it ourselves. And while we are on the subject, please note that in the issue before you, we have a page entitled "The Editor's Mail Bag." We ought to receive a sufficient number of good, conscientious letters from our readers regularly to fill up that page every month. Why don't you write us a short letter now and then? Tell us what you want and we will do our best to publish it. A little friendly criticism now and then, is relished by the best of Editors. We can't read your mind, therefore tell us what you think—it will cost you three cents—that's all. Now for the "May" E. E.:*

"How Radium Emanation is Helping to Cure the Sick," by George Holmes.

"Electric Vacuum Tubes—The Principal Types and Their Uses," by H. Winfield Secor.

"Shooting Electrical Troubles on Automobiles—A Clear Treatise on How to Test Your Battery, Motor, Generator and Wiring."

"Experimental Electrical Furnaces"—an instructive and well illustrated discourse by an expert.

"New Electric Stage Tricks."

"Theory of Tuning, Wave Lengths and Harmonics"—of distinct importance to all Radio Students, by Prof. F. E. Austin, Instructor Electrical Engineering, Dartmouth College.

"Experimental Mechanics"—Part III, by Samuel Cohen.

"How to Build an Electrically Played Piano"—a real "live" article, by Charles Horton, Consulting Engineer.

"Research and Its Importance to Human Progress," by Dr. W. R. Whitney, Research Laboratory, General Electric Co.

"Wave-meters—Their Uses and Construction"—Part III, by Morton W. Sterns.

"Then this is the method by which the Martians have made themselves invisible to us!" I exclaimed.

"There is no doubt about it. They had only to inclose their planes in cylindrical or spherical coverings, built on the principle of this bracelet; but, of course, on a tremendously larger scale. Then, by applying the silencer to their motors, they could approach us unseen and unheard, to plant the contact points for the atomic detonators wherever they chose and send them off with a current from their selenium cells as soon as they were at a safe distance."

"Why didn't the selenoid towers record their presence?"

"For the same reason that our eyes didn't. The sol-rays past *around* their mirrored surfaces, so no image was recorded on the plates."

"Does this mean that you can now prevent further attacks?" asked Ava. She had risen and stood like a goddess from her own planet, her whole figure tense with the sudden animation of hope and victory.

Firman and I started, almost guiltily. In the satisfaction of having solved the mystery we had forgotten the danger still ahead of us.

Firman smiled up at her admiringly. Something of her unearthly beauty had arrested even his usual cold indifference to the charm of femininity. "You are right," he admitted. "Our work has only begun. But I have an idea that may work out successfully. Bring your precious bracelet in here."

He lifted his immense frame from the chair and led us to the projecting room adjoining his laboratory. Arranging his apparatus, he placed Ava's arm before a Helium-Planoscope screen and with a few swift adjustments directed a powerful helium ray upon it. Eagerly we crowded around it. An outline of the flesh and bones greatly enlarged was visible, as in an ordinary X-ray photograph, and around the wrist *was a circlet of tiny bells!*

I found myself clearing my throat hoarsely as tho choking. Before I could utter a word of explanation Firman was saying with deep satisfaction: "Just as I expected! The substance of these mirrors is transparent to the helium ray. Now, then, you two leave me alone to work out my plans—and, Elvan—" He caught me by the shoulder as we were passing out. The deep lines in his swarthy face wrinkled with sudden relief into a grim smile. Sheer mental power had seen, grasped and already was at work on the problem. The acquisitive, searching brain had selected, classified and was inwardly ordering about the principles of science that would cope with the menacing disaster. He dropt into an almost whimsical mood, the great commonplaceness of him returning to ordinary banter.

"When the Council meets again, Elvan," he went on, "let them get ready a final answer to the Martian demands; let them tell those damned devils that they can go right straight to—O, I beg your pardon—I forgot the girl! Well, anyway—Good night! I'll call you as soon as I have things shaped up." In another moment he was gently but firmly thrusting us into the outer corridor. His door shut with a decisive snap that found an answering echo of confidence in my heart. The master was at work!

Sunday past quietly. The outside world knew little or nothing of the mighty project at work within that fateful laboratory. That same evening the Interplanetary Coun-

(*Continued on page* 871)

"Yes or No" an Electrically made Drama

By George Holmes

HUMAN nature! An unfathomed source from whence must spring the theme upon which every truly successful play is built. First-nighters and frequenters of New York's "Gay White Way" have been literally "fed up" with the eternal triangle; therefore it is somewhat of a miracle when a new play can so impress an audience as to make it sit up and take notice!

The seemingly impossible has been realized in Anderson and Weber's new theatrical production bearing the title—*"Yes or No."* Under a new setting and manner of presentation we see a vital human issue argued and answered in the "uptown home" amidst richness, sumptuousness and splendor—and on the other hand in the "downtown home" with poverty, pathos and squalid surroundings on all sides. A most graphic story of American wives and their homes.

The play proper is preceded by a prologue revealing a discontented wife about to run away from home with her neglectful husband's false friend. As she wavers on the brink, hesitating whether to say "yes or no" —the voices of her aunt and mother speak —and beg her to listen to a story of two women and how they met the same crisis in their lives.

Then follows the dual story of how two neglected wives each met a situation in which they were highly tempted to wander from the straight and narrow path. The wife of luxury, whose particular curse has been idleness, yields to temptation and rues it; the other who has seen nothing but drudgery resists and is more fortunate.

The epilogue brings the two stories together and the experiences set forth teach the wife of the prologue a strong lesson.

The cast is notable, both by its numbers and excellent portrayals. Suffice it to say that everyone acquitted themselves admirably.

The stage mechanism of this simultaneous narrative has been conceived by Jesse J. Robbins, and is a distinct as well as surprising novelty. The various settings are permanently arranged on three movable platforms, with guides arranged to keep them plumb and in place. They operate noiselessly, being supported on rubber tired wheels. The electrical equipment, including the lighting and the control of the electric motor is such that it moves with the platforms.

A large electric motor is set in the cellar as shown, of about 10 horse-power capacity and arranged with two rope winding drums, one of which revolves rather *fast,* and the other *slow.* The "prologue" takes place on platform No. 1—and while the two voices are speaking, telling the young wife to hesitate, the platform in the semi-darkness (this scene taking place with just a ray of moonlight coming thru a bay window) is moving slowly toward the back or "up stage." This is accomplisht by the operator in the cellar who pulls on cable No 1, by winding it on one of the motor driven drums. As soon as the last words are spoken, the stage is in darkness and scenes numbers two and three are quickly brought together with cable No. 3 by snubbing it on the fast drum—Scene two being the "uptown mansion" and scene three the "poor down-town home." By an ingenious arrangement two moving curtains, working automatically, block out scenes two and three while scene one is being moved, but as soon as that has been set back, the curtains keep moving to it so as to be out of the way when scenes two and three are brought together.

There is no division wall between the two sets and both are always in view. But only one scene is used at a time. Attention is focused on the side where the action is progressing by a clever arrangement of lights.

On the front of the auditorium balcony are six pairs of "baby spotlights," one in each pair giving *amber* light and the other *white* light. When the scenes of luxury and idleness are progressing, they are illuminated with amber light; the other side of the stage being in deep shadow. The tenement scene, in turn, is flooded with white light and the amber rays dimmed. The effects of contrast are telling and exceedingly novel.

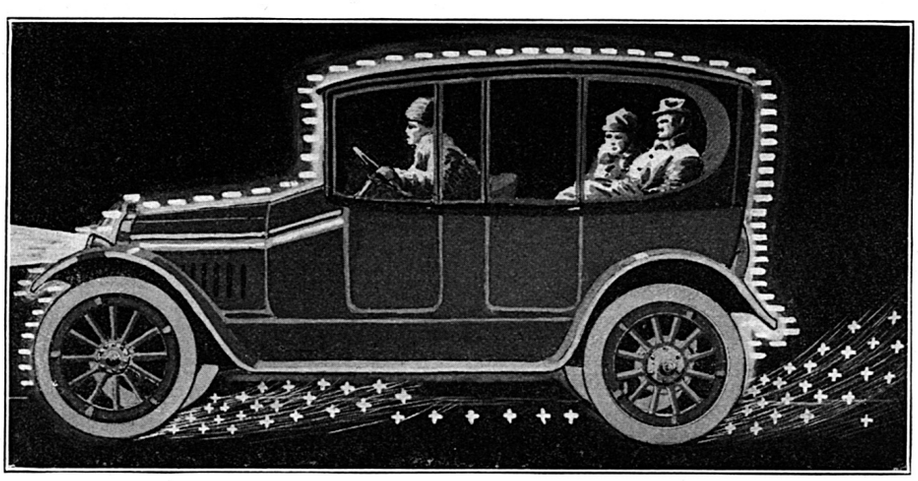
After the first act the two clamps on cable No. 3, are placed in the new positions, P1 and P2, as indicated. The end of cable No. 3, with clamp No. 1 is shifted to platform 3—position (P1) by the stage attaches, while clamp No. 2 is shifted to platform 2—position (P2). Each platform has a small trap-door as indicated, which gives ready access to cables and clamps. The work of changing the clamps on the cables is the work of but a few seconds and easily accomplisht. The positions of platforms 2 and 3 are not changed during the progress of acts one, two and three.

At the end of the third act the stage is darkened and cable number 3 is worked on the motor-driven drum in same direction as previously, thereby pulling the two platforms apart. Cable number two is pulled next, bringing platform number one and its setting "down stage." Then the lights go up, friend wife sees how narrow has been her escape, hubby comes home, and this being her birthday, a grand party takes place and "all's well that ends well."

STATIC ELECTRICITY AND THE AUTOMOBILE.

Have you ever stood on a crisp, cold winter morning on one of our asphalt streets and watched automobiles whizzing past, which may have temporarily blocked your progress across the streets? Like as not you have heard a peculiar swishing sound not unlike the sound produced by escaping steam, the sound being apparently produced by the wheels of the automobile. It probably occurred to you that this sound was totally unlike the sound you hear at other times of the year, as for instance on a warm summer morning or on a wet day.

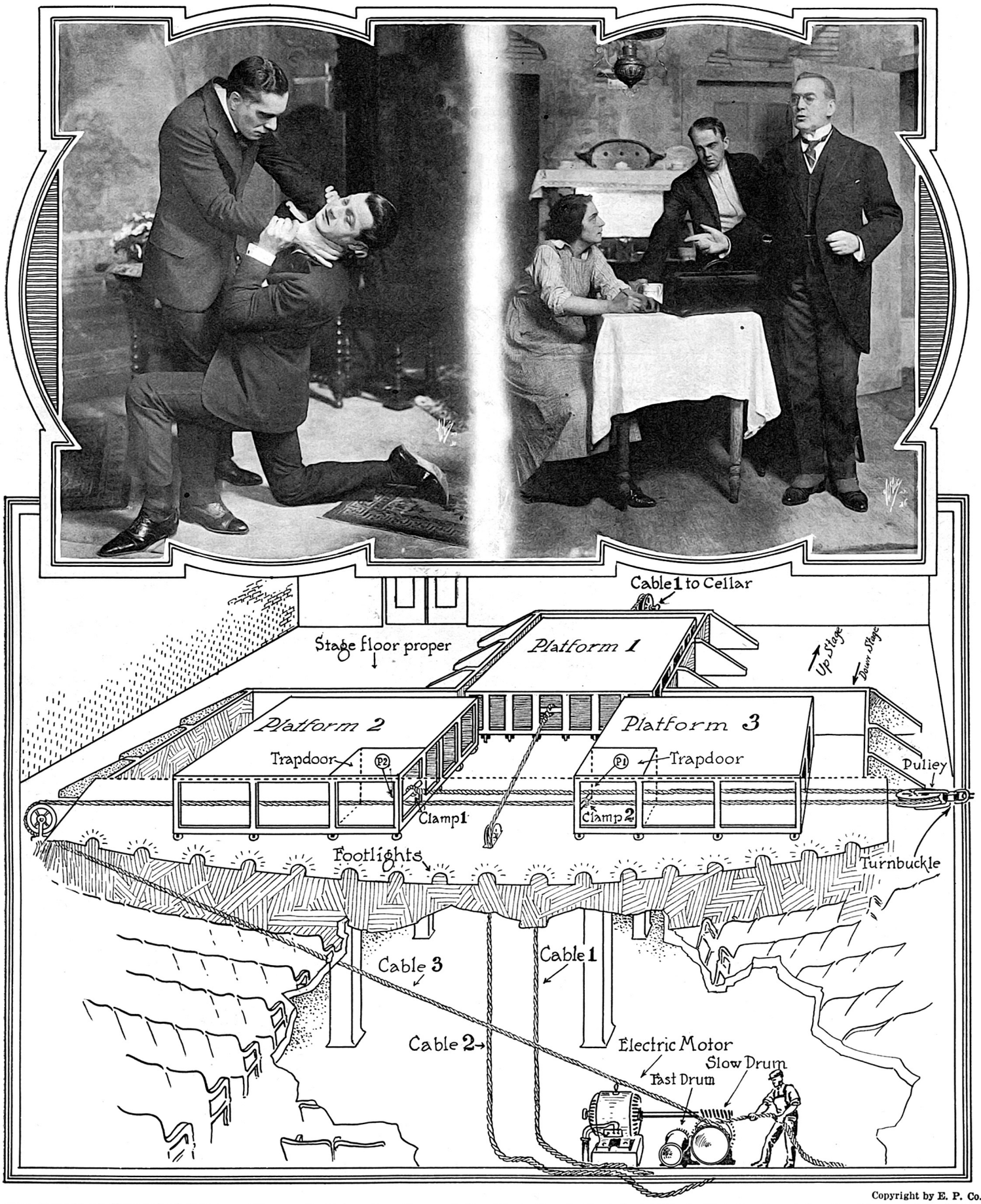
If you are at all observant you must have wondered at the great difference in sounds. There is, of course, an explanation. On a cold, crisp winter morning, the conditions for static electricity are ideal. Any possessor of a static electric machine will readily confirm this; hence, we find that an automobile, which is nothing but a huge static machine on rubber rollers rubbing against a highly electrified asphalt pavement, produces static electricity in an abundant quantity. As any owner of a static machine knows if the crank is turned and the electricity escapes, a peculiar hissing sound is observed which is due to the fact that the static electricity escapes into the air. The same thing happens when an automobile runs at high speed along the asphalt, the electricity emerging from the rubber tires and escaping into the surrounding air with the aforementioned swishing noise. In this case the automobile is negatively charged, while the ground (asphalt) is positively charged, and the high speed of the rubber tires rolling along the asphalt produces a sufficient electro-static stress which may amount to several thousand volts. This, of course, charges or electrifies the automobile to a high degree, and it has often been noted by motorists, that long sparks can be drawn from such an electrified automobile the minute it comes to rest. Of course, this charge is dissipated and lost a few minutes after the car comes to rest.



Did You Ever Hear the Strange, Swishing Sound Made by an Automobile, Running Along the Asphalt on a Clear Cold Winter Day? If You Did You Heard a Static Electricity Discharge.

While there is no danger, as a rule, by thus highly electrifying an automobile, it sometimes happens that should a person, who had not been riding in the same car and who stands on the ground should touch the gasoline tank (which perhaps had been leaking), an explosion often follows. The reason for this is that the car is still highly charged, while the body of the third person presents a good path for the electricity to surge into the ground, and if the spark made is anywhere near the gasoline tank, of course, results are apt to be disastrous. Using anti-skid chains on auto wheels obviates this.

"YES or NO" presents New Stage Features



Copyright by E. P. Co.

The New York Theatrical Success, "Yes or No," Involves Some of the Most Novel Electrical Effects Yet Produced on the Stage. We Are All Accustomed to See the Front Curtain Rise and Fall on the Successive Acts in a Play. But Here No Curtain Is Used. Even While the Scenes Are Being Changed, a Powerful Electric Motor, Located underneath the Stage, Solves the Mystery of Moving the Scenes Noiselessly and Quickly in the Fraction of a Minute. In "Yes or No," the Prologue Takes Place on Platform No. 1; While the two voices are Speaking, the Stage Assistant in the Basement Snubs Cable No. 1 on the Motor Drum—This Slowly Moves Platform One to the Rear—All in Semi-darkness. In a Few Seconds the Stage Attaches Have, by Snubbing on Cable No. 3, Brought Platforms Nos. 2 and 3 Together, Which, by a Clever Electric Lighting Effect, Produce Alternately the Dual Scene of Luxury and Poverty Above Illustrated. By Reversing the Platform Cable Clamps the Scenes on Platforms Nos. 2 and 3 Are Pulled Apart, and, by Snubbing Cable No. 2, Scene One Is Brought Down Stage for the Close.

The Electrical Production of Synthetic Gasoline

THE world needs gasoline—thousands of internal combustion engines are daily consuming untold gallons of the valuable fuel and have sent the price skyward at a rate that would give the average motorist heart failure. And just at the time that the situation promised to become acute an inventor comes forward with an electrical method of producing it from kerosene, solar oil and low-grade distillates.

Briefly the process is as follows: Take some kerosene, vaporize it, mix in a little natural gas and shoot a bolt of electricity thru it. Wash with acid, soda ash and water, then distill and you have pure, water white gasoline that will clean kid gloves or drive a motor car. Simple, isn't it?

But it took two years of experimental work to bring the process to its present practical condition. One of the illustrations herewith show Mr. Louis B. Cherry, the inventor of the process, and the first plant that proved his ideas practical.

In order to understand the working of the Cherry process for producing gasoline it would not be out of place to describe briefly the usual process of distillation of crude oil. Then a better idea will be gained of how the new process can be readily adopted to the present refineries.

The oil as it comes from the well is black in color, having a disagreeable odor and quite thick. In this form it is known as crude oil and, depending on the part of the country from which it comes, will have very little gasoline, or possibly as high as 15 to 30 per cent of gasoline, in it.

This oil is pumped into a large still which may hold from five to fifteen hundred barrels. This still is usually of cylindrical form and is mounted on brickwork similar to a horizontal steam boiler. Fire is placed under the still and the temperature of the oil gradually raised. When it reaches a temperature of 90 to 100 degrees, Fahrenheit, gases will pass over into a condenser which consists of a large coiled pipe immersed in a tank of water. These vapors condense and thus is obtained high-proof gasoline or petroleum ether.

The temperature is further raised until all the gasoline vapor passes over. The end point or the maximum temperature at which gases are allowed to pass over is 400 deg. F. This fraction or *cut* is known as crude benzine by the refiners and is then treated with sulfuric acid, soda ash, washed with water and redistilled. This results in the commercial gasoline used for motor cars.

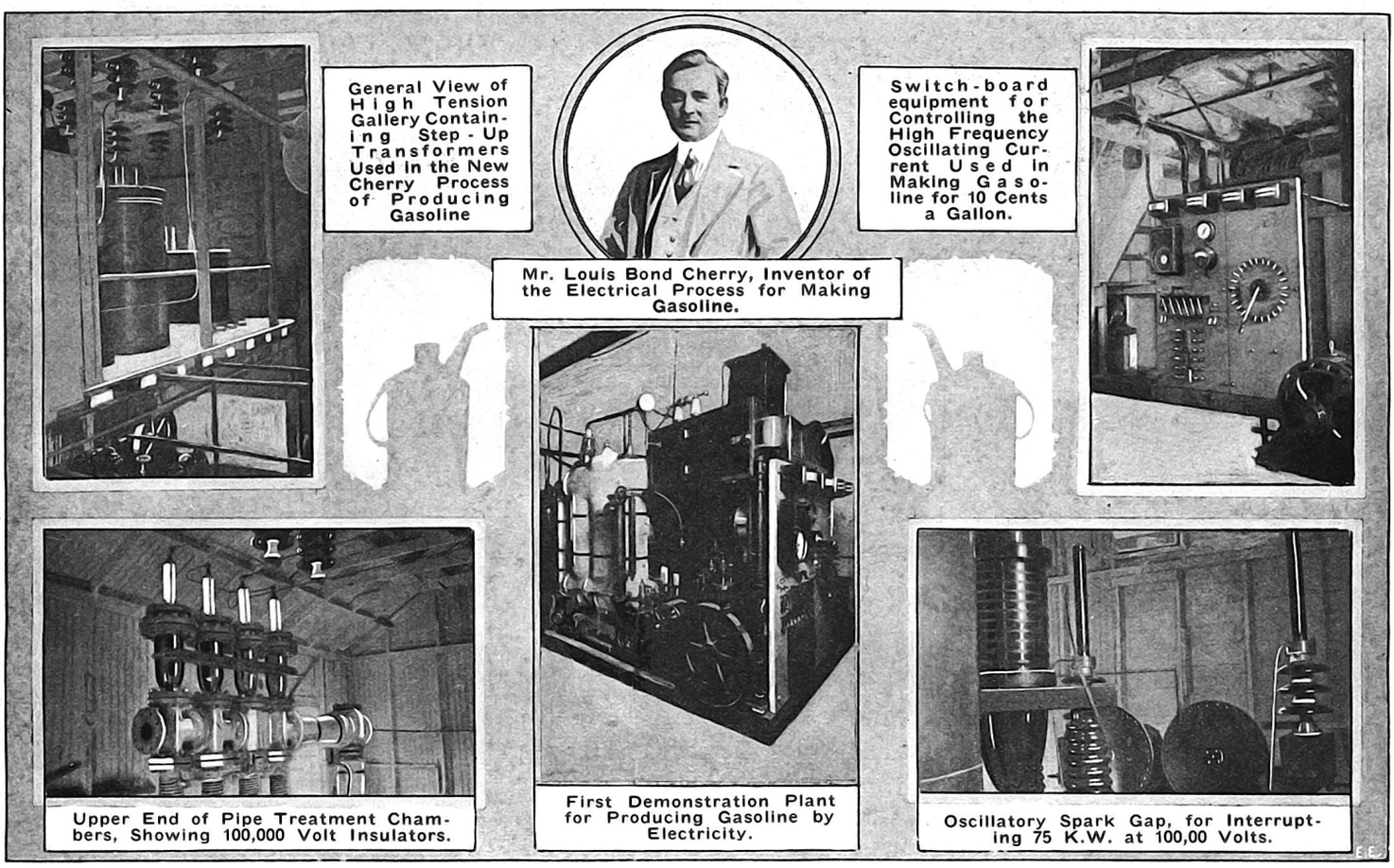
The above process takes out all the gasoline, further heating causes kerosene, solar oil and heavy lubricating oils to pass over and condense in turn. This operation is known as *fractional distillation,* the residue remaining in the still after a high temperature is reached being coal tar, which is the source of our dyes and other products.

Now turning to the Cherry process. It is a well-known fact that all crude oil products from gasoline to paraffin wax are hydrocarbons—that is, they consist of varying mixtures of hydrogen and carbon. It is apparent that were some means found for controlling the relative proportions of the hydrogen and carbon it would be possible to produce any of the various products at will; that is, obtain all paraffin or all gasoline, as desired. By studying the constituents of the various hydrocarbons, Mr. Cherry noted the fact that if natural gas could be combined chemically in proper proportions with the various distillates, he would then have gasoline. Acting on this he discovered that a high-tension electric current would affect the necessary reaction and produce gasoline.

In practise, the still used is similar to that employed in refining crude oil, but has a perforated pipe at the bottom. The kerosene or other low-grade oil is placed in this still and while being heated natural gas is forced into the perforated pipe and escaping up thru the liquid is heated to the same temperature and thoroly mixed with the oil vapor. This vapor then passes into a series of electrically heated pipes that have a central electrode, this electrode as well as the pipes being connected to a source of high-tension current of extremely high frequency.

The gases are subjected to this silent discharge as they flow thru the pipes and their chemical structure is so altered that the resulting condensate is a crude benzine. For the proper results it is necessary that the temperature of the gases, their rate of flow, as well as the voltage and frequency of the current be properly adjusted. On treating the benzine so obtained a liquid results that cannot be detected from gasoline—in fact, it is gasoline!

To produce 60,000 gallons of gasoline by the above process daily, an electrical equipment rated at 75 K.W. (75,000 watts) is required. The illustrations give a good


General View of High Tension Gallery Containing Step-Up Transformers Used in the New Cherry Process of Producing Gasoline
Mr. Louis Bond Cherry, Inventor of the Electrical Process for Making Gasoline.
Switch-board equipment for Controlling the High Frequency Oscillating Current Used in Making Gasoline for 10 Cents a Gallon.
Upper End of Pipe Treatment Chambers, Showing 100,000 Volt Insulators.
First Demonstration Plant for Producing Gasoline by Electricity.
Oscillatory Spark Gap, for Interrupting 75 K.W. at 100,00 Volts.

idea of the apparatus employed in a plant of the above size. The general view of the high-tension gallery shows the transformer in the background, with the condenser used in the closed oscillating circuit at the left. Another illustration shows the rotary spark gap having two large rotating disks fitted with plugs to obtain a high rate of discharge thru the closed circuit, the primary of the oscillatory transformer being shown at the left.

The treating chambers are shown in another illustration in which the mixed vapors are treated. The large porcelain insulators can be clearly seen that insulate the central electrodes. The pipes are also wound with electric heating coils to obtain the proper temperature.

All this apparatus is controlled from a switch-board that is shown in another illustration, which also mounts the meters that indicate the currents flowing in the different circuits at any time.

The entire operation taking place at atmospheric pressure, it is a simple matter to fit the ordinary crude oil still with the necessary treating chambers and electrical equipment. Tests tend to prove that the cost of treating *one gallon of kerosene does not exceed one cent,* while the value of the process will be better appreciated when it is stated that it is practical to convert nearly all the volatile oils into gasoline without undue precipitation of carbon or the production of fixt gases.

At a recent test *it was possible to change* 78.68 *per cent of the kerosene used into pure gasoline, but the plant under construction is expected to raise the percentage to* 98 *or* 100. Mr. Cherry has offered to furnish the government all the gasoline it requires for a flat rate of 10 *cents per gallon,* and to say the least this offer has caused quite a commotion among those interested in gasoline production.

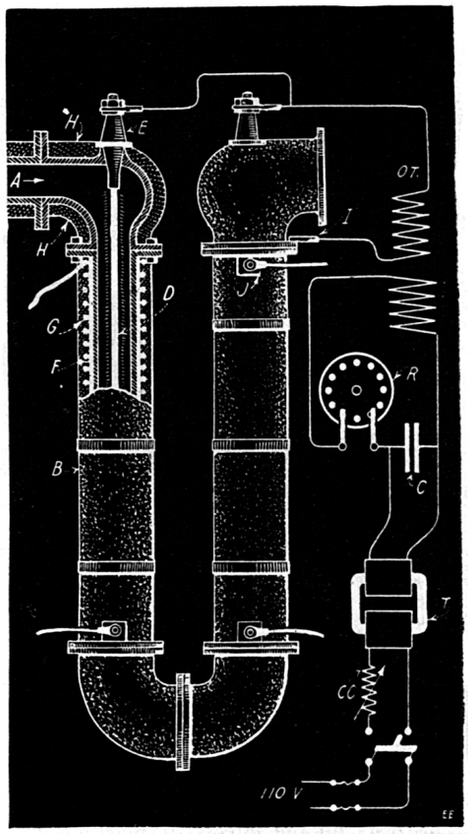
Is this but another step along the road to the production of gold from the baser metals? According to the more recent theories of the electrical nature of matter it should be possible to affect such a change by electrical means. All matter being made up of electrical charges, it merely remains for some one to find a way of controlling the grouping of these charges and they can instantly produce anything from the material in hand.

The kerosene vapor with which has been mixed natural gas, enters at A and passes into pipe B. The latter is of iron covered with a layer of electrical insulation, such as mica, shown at F, over which is wound the resistance wires G, for heating the chamber. These wires are in turn covered by a thick layer of heat insulating material to retain the heat and keep the temperature constant.

The electrode D is mounted centrally in the chamber, being supported and insulated by the porcelain E. At J is shown the terminals of the heating winding.

The sectional view also shows the wiring to produce the high tension high frequency currents required to treat the vapors. An alternating current supply is connected to the primary of the step-up transformer T, thru a choke coil CC. A condenser C is shunted across the secondary of the transformer, while a rotary spark gap R serves to discharge the condenser periodically thru the primary of the oscillation transformer O. T. In this manner high frequency currents are induced in the secondary of the oscillation transformer, which flow to the rods D, connection being made from the other terminal to the pipes as shown at I.

The heating coils are connected to the current supply thru an adjustable resistance not shown in the drawing.



Sectional View of Electrified High-Tension Vapor Chambers Used in Producing Synthetic Gasoline.

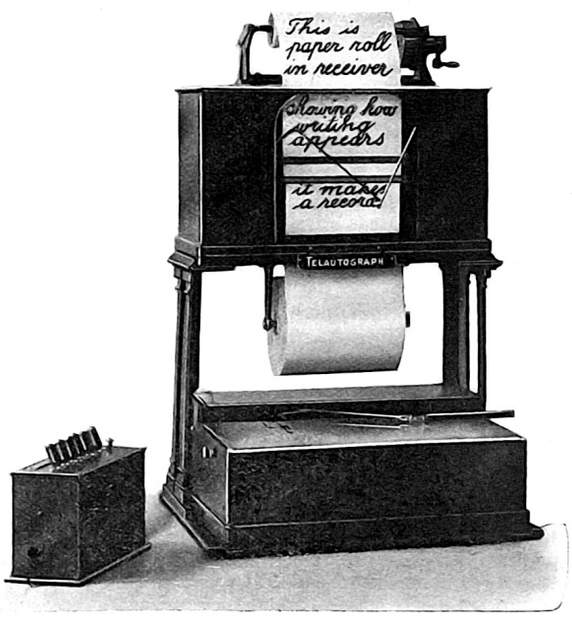
ARGENTINE GOVERNMENT WANTS ELECTRIC VOTING MACHINE.

The Argentine government has invited American electrical manufacturers to submit bids on making and installing an electric voting machine in the chamber of deputies of Argentina.

The Telautograph

What It Is

The Telautograph, practically unknown to the vast majority of people not actively engaged in business, has become during recent years a very familiar and important part of the message transmission in commercial and industrial life of this country. The Telautograph, as its name indicates, being derived from the Greek words "Tele" "Auto" and "Grapho," means, literally translated, one's writing at a distance. It is a little more than a telegraph, in that the actual handwriting of the operator is transmitted almost in facsmile.



The "Telautograph"—the Electric Machine That Writes. Intercommunicating Switch-box at Left Which Connects Any Desired Station.

To express it in another way, with the Telautograph you write over wires as with the telephone you talk over wires.

History.

As with almost every new and important invention the history of the development of the Telautograph is interesting, because it has spread over a long period of years and has required constant and unceasing effort of many inventors before the instrument was brought to its present commercial and practical construction.

Telautographs in one form or another have been invented and patented as far back as 1876, followed by different ideas for acomplishing the same purpose in subsequent patents issued to different men in the United States and England in 1879, 1884, 1886 and 1888. In these early types of telautographs the paper on which the message was written by the operator and also that on which it was traced by the receiving pen was caused to move continuously, necessitating considerable skill on the part of the writer in forming the characters to assure a legible reproduction of handwriting and affording no facilities whatever for the transmission of figures and sketches.

A story is told by an old Chicagoan that one day in the winter of 1886, or 1887, he entered the office of a friend, a well-known Chicago financier, and found this financier gravely watching a tall, gray-bearded man manipulate a cane and umbrella which had their handles hooked together, and was sliding them about over the top of a flat desk while he told of a new kind of telegraph that he had gotten up. The gray-bearded man was Elisha Gray, of telephone fame, and with the cane and umbrella he was demonstrating the principle of the now well-known Telautograph pen-arm movement.

Whether this story is true or not, it was about this time that Mr. Gray built his first telautograph. It was smaller than a grand piano and its mechanism was composed mainly of weights and strings, but it worked and actually transmitted handwriting after a fashion over wires between the inventor's house and his laboratory, about five hundred yards distant.

The results obtained with this crude instrument were sufficiently encouraging to Mr. Gray to cause him to put in a great deal of hard work during the next few years, endeavoring to develop an instrument that would be suitable for commercial use.

(*Continued on page* 874)

Electricity in French Machine Gun Tests

Fig. 1—A French Underground Electrical Laboratory in Which Machine Gun Tests Are Conducted. The Audible Time of Reaction of a Machine Gun Is Being Measured.

Fig. 2—This Picture Shows M. Laby, French Military Expert and Scientist, Conducting an Electrical Test for Determining the Respiratory Variations of Rifle Fire.

Fig. 3—Experimental Apparatus Used In Studying the Rapidity of the Shocks of the Machine Gun, in the Repetition of a Movement.

ELECTRICITY often finds peculiar applications in the present World War. Here are several views of a battlefield laboratory in France—that of M. Laby, the distinguished French expert, who is seen conducting exacting tests on the effects of machine gun operation on soldiers, as well as other researches on the action of these small but highly effective fire-arms, some of which are capable of firing from 400 to 1,000 shots per minute.

Thus it is no easy problem to split up the seconds and fractions of seconds transpiring while one shot is occurring. The French machine guns have withstood the most rigid tests.

Fig. 1 shows M. Laby measuring the audible time of reaction of a machine gun. On the table is a Ruhmkorff coil, used to produce a spark for the rupture of the current as well as a variety of other electrical precision apparatus. This laboratory is in a bomb-proof cave.

Fig. 2 illustrates another French machine gun test—registering the respiratory variations of rifle fire for the study of functional plasticity. M. Laby, the distinguished French expert, seen at the extreme right of the photo, is conducting the tests.

The illustration, Fig. 3, shows the electrical apparatus for the study of the rapidity of the shocks of the machine gun in the repetition of a movement. These tests are being made also under the supervision of M. Laby, military expert of the French Army.

HEALTHFUL HEATING OF THE TISSUES BY ELECTRICITY.

By Dr. Leonard Keene Hirshberg, A.B., M.A., M.D. (Johns Hopkins University).

IF you can heat the human fabric by a variety of electricity, which has other virtues also, you may begin to relegate the *hot-water bag* to the rear. This can be done.

Several thousand "milliamperes" or small electric units, can be past thru the living body with alternations of the electric current which amount to several millions a second. This yields a high degree of heat which passes thru the skin the same as X-rays do. It is called "diathermia" or thru heating.

This form of electricity is little known and therefore seldom used. Yet it performs wonders in the way of healing the tissues.

Dr. Albert C. Geyser, Professor of Physiological Therapy at Fordham University, New York City, stands in the forefront of those who espouse the wide use of this type of electricity for the treatment of joint inflammations, swollen joints, and various kinds of arthritis.

It is the "high frequency" electric current, which makes this kind of heat. The resistance of the human textures to electricity is like their resistance to the fluid in a hypodermic syringe.

If you would understand about this, you can picture the electricity as the fluid in the syringe. To overcome the resistance of the tissues, you must force the stuff strongly enough to overpower the resistance.

Then you have deposited in the tissues the contents of the syringe or the electric machine. An *ohm* is the unit used by science to measure the amount of resistance to the spread of the electricity, just as *pounds* is used to measure the amount of pressure needed by water to overcome resistance.

A *volt* is the electric unit of pressure, and the rate of electric speed or flow is called the *ampere*. You could say of the syringe that the *amperage* or rate of flow into the human fabric needs an adequate amount of pressure or *voltage*, exerted upon the piston to overcome a certain amount of resistance or *ohms*. Thus if you read that a lineman was electrocuted by several thousand volts, you know it was the *electric pressure*.

Alternating current electricity is a current made by changing or alternating the direction of the electric flow or vibration 120 times or more a second. It is an electric current, which flows in one direction only 1/120 of a second, stops like the pause between two heart beats, and abruptly changes its direction. A complete cycle is then 1/60 of a second or sixty cycles to the second. When such a current alternates at more than 10,000 cycles per second, it is termed a *high frequency* current.

If such an alternating current is past over a spool—called a coil—or wire on a cylinder, so one can slide inside the other, the latter coil or secondary circuit receives and has induced into it a series of electric shocks from the primary coil.

The primary coil consists of fewer turns of coarse wire than the superimposed secondary coil. This has thousands of convolutions of fine wire.

This ratio of 1 to 1,000 has an important bearing on the voltage. If the primary coil gave 100 volts, 1,000 extra turns on the seconary will multiply the voltage to 100,000. This has been gained at the expense of rate of flow or amperage. This is known as a *step-up transformer*. A step-down transformer is made by having the finer wires in the primary and the coarser wire on the secondary coils.

High frequency electricity is made at first from "a step up" transformer. When these 100,000 volts are led into a pair of metal lined glass jars, called *Leyden jars*, which you can see in any electric supply house, it leads the current into a condenser.

A condenser is a device where electric conductors such as metal, salt, the human body, or what not, are separated by some non-conductor such as glass, tissues, or rubber, which act as an electric sponge.

A spark gap is connected with the Leyden jars. When the gap is closed the current flows onward. The negative and positive direction of the flow is quickly equalized. Every electric current, like gas or water, takes the path of least resistance.

Open this gap ever so little, and it offers a resistance to the electricity. As a consequence it spreads all over the inside of the Leyden jar, until it accumulates a pressure strong enough to overcome and force its way across the gap that is open.

(*Continued on page* 858)

Electricity to Prevent Future Fuel Crisis

BY

William H. Easton, Westinghouse Electric & Mfg. Co.

"IT must never happen again"—is the unanimous verdict of Americans on the present fuel crisis. Much has been said in the past concerning the necessity for conserving fuel, but now that we have actually suffered from a shortage of coal there is no further room for academic discussion. The time has come for action, and the important question of to-day is, therefore—"What can be done to avoid powerless factories and heatless homes, under no matter what unfavorable combination of circumstances?"

Our present difficulties arise from two causes: We need more coal than can be mined, and the railroads, with their extra burden of war work, are unable to handle such coal as is being mined. A plan, therefore, that would, while providing us with ample power, reduce our coal consumption per horse-power by at least one-half, and would at the same time increase the capacity of the railroads and also reduce to a fraction the amount of coal to be transported by the railroads, would appear to be a complete remedy for our troubles.

Fortunately, we have such a remedy at our disposal and tho little or nothing can be done until after the war, except to use our existing facilities as efficiently as possible, the application of this remedy is certain to be the great work of American engineers during the next decade. This remedy consists in a general *electrification* of our industries, including much of our railroad mileage—the current to be supplied from huge central generating stations connected together by power transmission systems hundreds of miles long.

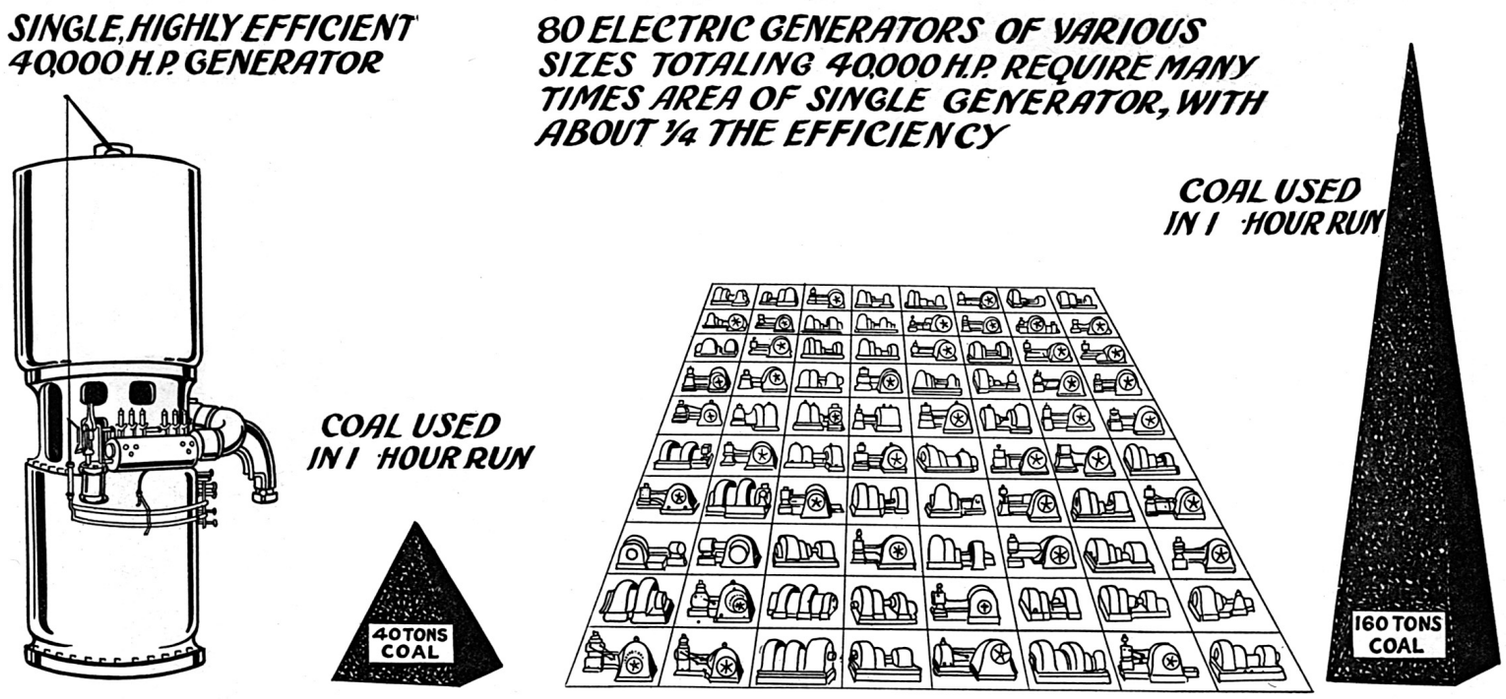
single cites or to relatively small areas. The time has long past when a man can raise his own food, make his own boots, and provide his own transportation, nor can these things be done by local concerns. Economy demands that most of our demands be supplied by agencies of a national, or indeed international, scope. The same is true of the generation of power. Small scale production is now out of the question.

Were great electrical systems, such as described, now in operation, the present fuel crisis would not have occurred. The main reasons for this statement can be summarized as follows:

1. Millions of horse-power of electrical energy would be generated from water-power and our coal consumption decreased by a corresponding amount.
2. Where coal would still be needed for power purposes (as in the East), it would be utilized in huge generating stations burning *less than one-half the amount of coal* now needed to produce the same amount of power.
3. Many of these large generating stations would be at the coal mines, and no railroad haulage would be needed to serve them.
4. The problem of bringing coal to those stations that would be situated remote from the mines would be vastly simpler than that of supplying the thousands of small plants that exist at present.
5. The electrically-operated railroads would be able to haul a much greater amount of freight in a given time than

need be said. The folly of consuming millions of tons of coal and oil when upwards of 60,000,000 horse-power of water-power are allowed to run to waste is now fully recognized, and one of the first steps that will be taken after the war will be to convert this waste into useful energy.

Coming to the second point, tho some water power is available in the important region east of the Mississippi and north of North Carolina, there is not enough to supply the needs of the vast industries located here, so that coal will still be required here for power purposes until some new method of developing energy is discovered. What is necessary, therefore, is a more economical method of using this coal. One of the important recent tendencies in electrical development has been the construction of very large single generators. Fifteen years ago a generator of 7,500 horse-power was considered immense; today several generators of from *40,000 to 60,000* horse-power are in operation and units of up to *100,000 horse-power* are under construction. These great machines are far more efficient than smaller sizes. A 40,000 horsepower generator can operate at full load for one hour on about *40 tons of coal* (1 carload); whereas *80 generators of different sizes* averaging 500 H.P. capacity each (totaling 40,000 H.P.), require from 80 to 160 tons (4 carloads) to run at full load for the same time. The accompanying sketch illustrates this fact forcibly. The amount of fuel that could be saved if most of our industries were supplied with power from such huge, centralized generators is obvious.


SINGLE, HIGHLY EFFICIENT 40,000 H.P. GENERATOR
80 ELECTRIC GENERATORS OF VARIOUS SIZES TOTALING 40,000 H.P. REQUIRE MANY TIMES AREA OF SINGLE GENERATOR, WITH ABOUT ¼ THE EFFICIENCY
COAL USED IN 1 HOUR RUN
40 TONS COAL
COAL USED IN 1 HOUR RUN
160 TONS COAL
BOTH OF THESE ELECTRIC PLANTS DEVELOP 40,000 H. P. WHICH WOULD YOU CHOOSE?

One Thing Is Certain—the War Conditions Imposed on Us Has Brought to Light Many Inefficient Methods of Producing and Utilizing Electric Power. This Graphic Illustration Shows in a Marked Manner Just What Happens When, in a Given Case, We Permit a Whole Handful of Little Steam-Electric Generating Plants to Operate on Coal Fuel, Compared to the Gain in Efficiency by Centralizing All These Individual Plants in One Unit.

It is true we are using electricity today to perform much of our work, but practically all this power is generated and distributed locally—either in small isolated plants or in central stations restricted to single cites or to relatively small areas. The time has long past when a man can raise his own food, make his own boots, and provide his own transportation, nor can these things be done by local concerns. Economy demands that most of our demands be supplied by agencies of a national, or indeed international, scope. The same is true of the generation of power. Small scale production is now out of the question.

Were great electrical systems, such as described, now in operation, the present fuel crisis would not have occurred. The main reasons for this statement can be summarized as follows:

1. Millions of horse-power of electrical energy would be generated from water-power and our coal consumption decreased by a corresponding amount.
2. Where coal would still be needed for power purposes (as in the East), it would be utilized in huge generating stations burning *less than one-half the amount of coal* now needed to produce the same amount of power.
3. Many of these large generating stations would be at the coal mines, and no railroad haulage would be needed to serve them.
4. The problem of bringing coal to those stations that would be situated remote from the mines would be vastly simpler than that of supplying the thousands of small plants that exist at present.
5. The electrically-operated railroads would be able to haul a much greater amount of freight in a given time than is now possible with steam operation. Let us examine these reasons in greater detail.

As to the first—the use of our immense supply of water power—nothing further need be said. The folly of consuming millions of tons of coal and oil when upwards of 60,000,000 horse-power of water-power are allowed to run to waste is now fully recognized, and one of the first steps that will be taken after the war will be to convert this waste into useful energy.

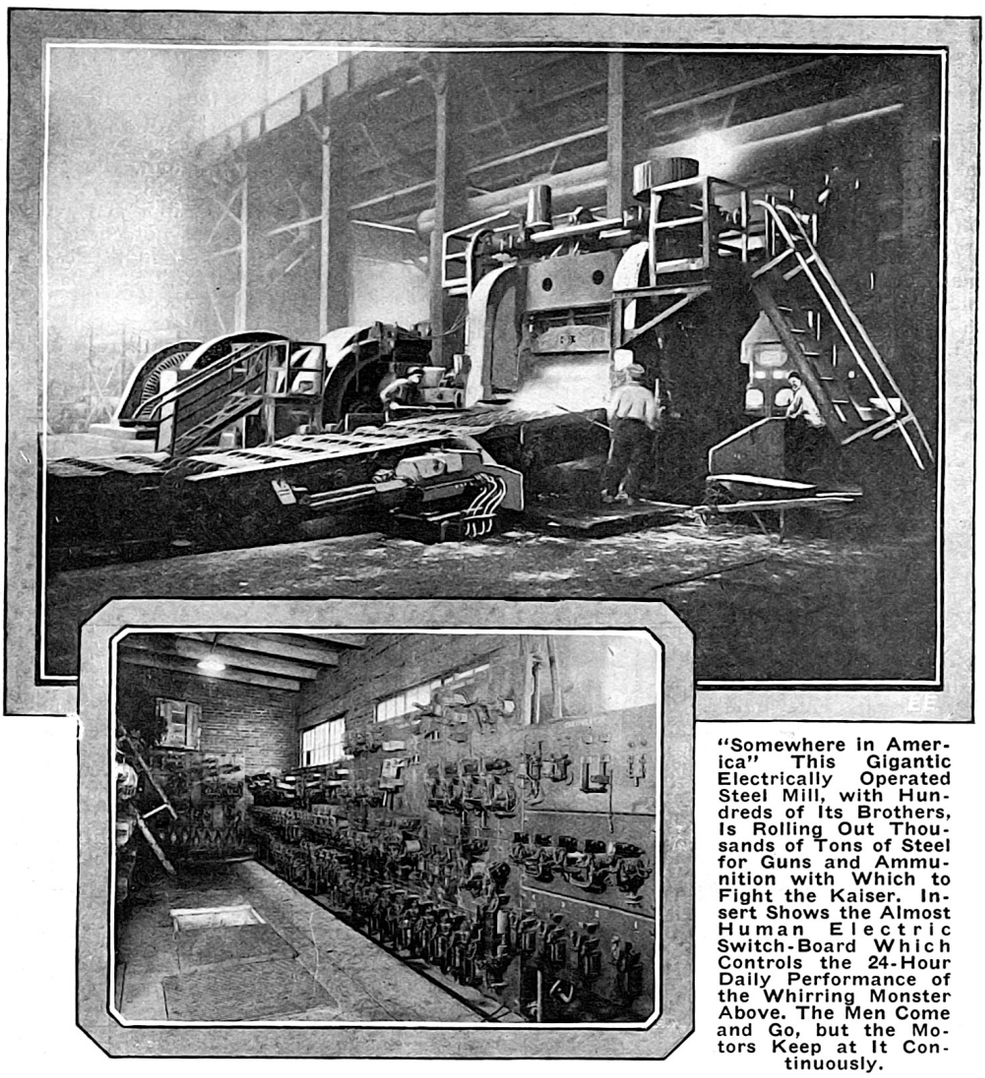
Coming to the second point, tho some water power is available in the important region east of the Mississippi and north of North Carolina, there is not enough to supply the needs of the vast industries located here, so that coal will still be required here for power purposes until some new method of developing energy is discovered. What is necessary, therefore, is a more economical method of using this coal. One of the important recent tendencies in electrical development has been the construction of very large single generators. Fifteen years ago a generator of 7,500 horse-power was considered immense; today several generators of from *40,000 to 60,000* horse-power are in operation and units of up to *100,000 horse-power* are under construction. These great machines are far more efficient than smaller sizes. A 40,000 horsepower generator can operate at full load for one hour on about *40 tons of coal* (1 carload); whereas *80 generators of different sizes* averaging 500 H.P. capacity each (totaling 40,000 H.P.), require from 80 to 160 tons (4 carloads) to run at full load for the same time. The accompanying sketch illustrates this fact forcibly. The amount of fuel that could be saved if most of our industries were supplied with power from such huge, centralized generators is obvious.

There is, however, a greater economy possible than the above figures suggest. Let us suppose that 80 plants, which formerly needed generators aggregating 40,000 H.P.,

(*Continued on page* 873)

How the Mystic Current Makes Steel

The accompanying illustration shows the gigantic electrically operated steel plate mill in a large Cleveland, Ohio, steel works. Some of these steel mills are driven by veritable monsters of electric motors, and to control them is not the easiest thing in the world. The white-hot steel billets emerge from the motor-driven rolls at the right, while off in a little room, hundreds of electric fingers are sending messages to the electric motors that run the machines.



"Somewhere in America" This Gigantic Electrically Operated Steel Mill, with Hundreds of Its Brothers, Is Rolling Out Thousands of Tons of Steel for Guns and Ammunition with Which to Fight the Kaiser. Insert Shows the Almost Human Electric Switch-Board Which Controls the 24-Hour Daily Performance of the Whirring Monster Above. The Men Come and Go, but the Motors Keep at It Continuously.

"Stop!" "Start!" "Slow!" "Reverse" is the endless, monotonous series of orders dispatched with the speed of lightning and the sureness of a trip-hammer blow.

Men may come and men may go at the steel plant but the automatic motor control switch-boards keep up the heavy stream of steel production 24 hours a day, week in and week out. Today, hundreds of these powerful electric steel rolling mills thruout the length and breadth of the land are humming away night and day — rolling, squeezing, and swaging the glistening white-hot ingots into sinews of war—guns, shells, torpedoes, aeroplane parts, engines, and stock for thousands upon thousands of other much-needed implements used by the American Sons of Mars.—*Photos courtesy G. E. Co.*

PLATFORM FARE BOX FOR SUBWAY SERVICE.

For handling large crowds, such as in subways, elevated stations, terminals, etc., a Chicago concern has developed a motor-driven fare box, which embodies several interesting features, as applied to the standard registering and counting mechanism which has been extensively used in street railway service for several years.

Heretofore large crowds at such points have usually been handled by means of non-registering hopper fare boxes which received *tickets* only, but with this improved box the paper tickets will be eliminated and the rider *will deposit cash fare directly in the box* as he passes thru the gates, the coins being automatically registered and deposited in a locked receptacle.

This station platform box has been tried out for several months in New York subway service with such satisfactory results that the Hudson & Manhattan Railroad Company has ordered a sufficient number of boxes to equip all of its stations, and a large order has recently been received from the New York Municipal Railway Corporation.

The hopper is of bowl construction, of liberal diameter, deep and with sufficient holes for all "rush-hour" requirements. As many as 119 *fares* have been handled by the box in *one minute;* its ability to handle fares is limited only by the speed with which it is possible to pass people thru the gates.

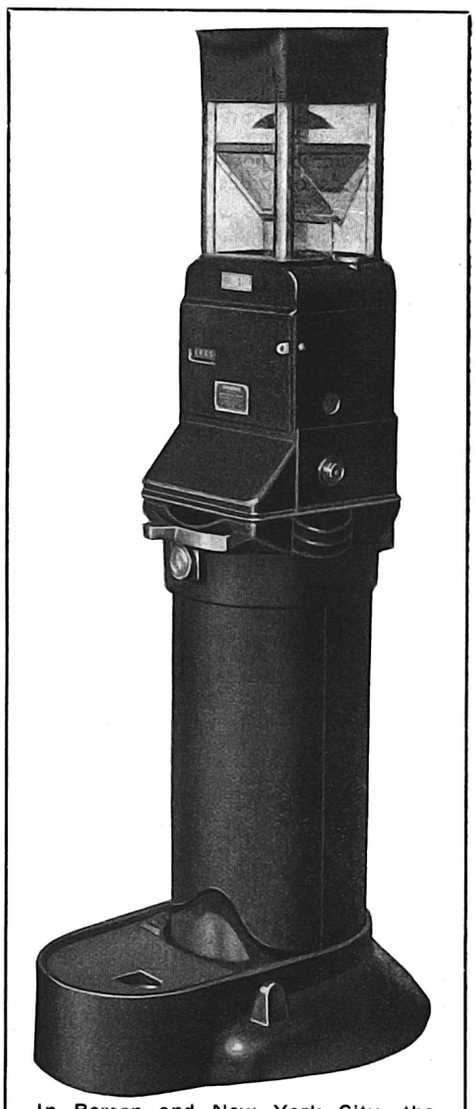
The inspection chamber is of ample size, allowing ample light, with "baffle" plates of simple construction, insuring the coins lying flat on the black coin belt, giving a clear view of all coins at all times, yet shielding the operator's eyes from all light by reason of the light being situated at the back of the box. The coin belt is of dark leather which causes all coins whether of silver, nickel or bronze, to show up in contrast, relieving the eye strain of the operator. This belt is operated over two rollers, the entire construction being very simple.

From the agent's or operator's standpoint, he has clear vision and ample time for coin inspection without eye strain. He has a small catch to stop the coin belt, if needed, to call a passenger's attention to a false coin deposited. Should a mutilated coin or foreign material be dropt into the fare box, clogging or stopping the machine, a small crank is supplied which allows the operator to force the foreign pieces thru and clear the machine from all obstructions.

Another valuable feature is, that during the removal of any of the parts of the mechanisms, the money is always fully protected, because in the design of this box the feature of having the operating mechanism entirely separate from the coin receptacle and chamber is fully carried out.

Further, with reference to collecting the money: The locking mechanism is so timed that the collector cannot insert and turn his key to unlock unless the current is out off the motor. This prevents the possibility of money deposited in the hopper being past thru the box should the coin receptacle be out of place.

After the collector has stopt the mechanism and unlocked the coin receptacle chamber, he cannot remove his key until the filled receptacle is removed and an empty one properly inserted and the coin receptacle is removed before the mechanism can be started again.



In Boston and New York City, the Subways Are Using This Motor-Driven Fare-Box. They Take Pennies, Nickles and Dimes, and Save Ticket Paper As Well As Congestion.

AUTO TRUCK "DOUBLES UP" AS LIGHTING PLANT FOR PARK.

An automobile truck was prest into service to furnish lighting current for the Yosemite National Park when it was found impossible to complete a new hydro-electric station in time.

WASHINGTON STATE COLLEGE TO HAVE SIGNAL CLASSES.

Washington State College, Pullman, Wash., will heed the call of the government for 15,000 trained men for the signal corps and will attempt to provide between 50 and 100 men qualified for this service in as short a space of time as is possible. Classes in signal corps work will be started immediately. Training will be given in the international wireless code, a speed of 20 words a minute in sending or receiving being required before the completion of the course. The code to be taught is used thruout the signal corps service in wireless, wigwag and buzzer signaling.

A storage battery of the size which allows it to be substituted for the standard dry cell is now sold for use in connection with portable electric lanterns.

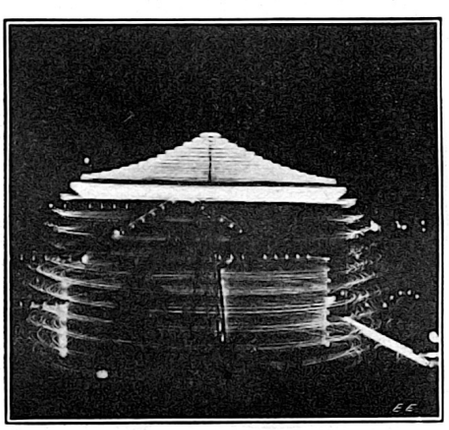
THOSE "ODD" ELECTRICAL PHOTOS.

The accompanying photo shows a really novel electrical effect—the kind we are after and stand ready to pay $1.00 cash each for. Say, readers, we really wonder if you have ever read the notice publisht on the title page of the "Question Box" in every issue for the past six months. This notice to all readers, whether regular subscribers or not, says that $1.00 will be paid for any photo we can use—but they should be "odd ones," like that below.

The present picture is—perhaps the Radio hounds will swear it's nothing but a highly charged helix—a short-time exposure of the electrically illuminated "Captive Aeroplanes" at Luna Park, Coney Island. The photo is not retouched and was copied directly. Now why can't we get dozens of other novel, odd, striking electrical photos? Something with a "kick" in them. Don't be afraid to waste a "film" or "plate"—take a crack at something. If at first you don't succeed, etc.—you know the rest.

Mr. Strickfaden took this photo, the original being of ordinary pocket kodak size, or 3¼ by 5¼ inches.

Now, readers, and there are several hundred thousand of you, for the love of

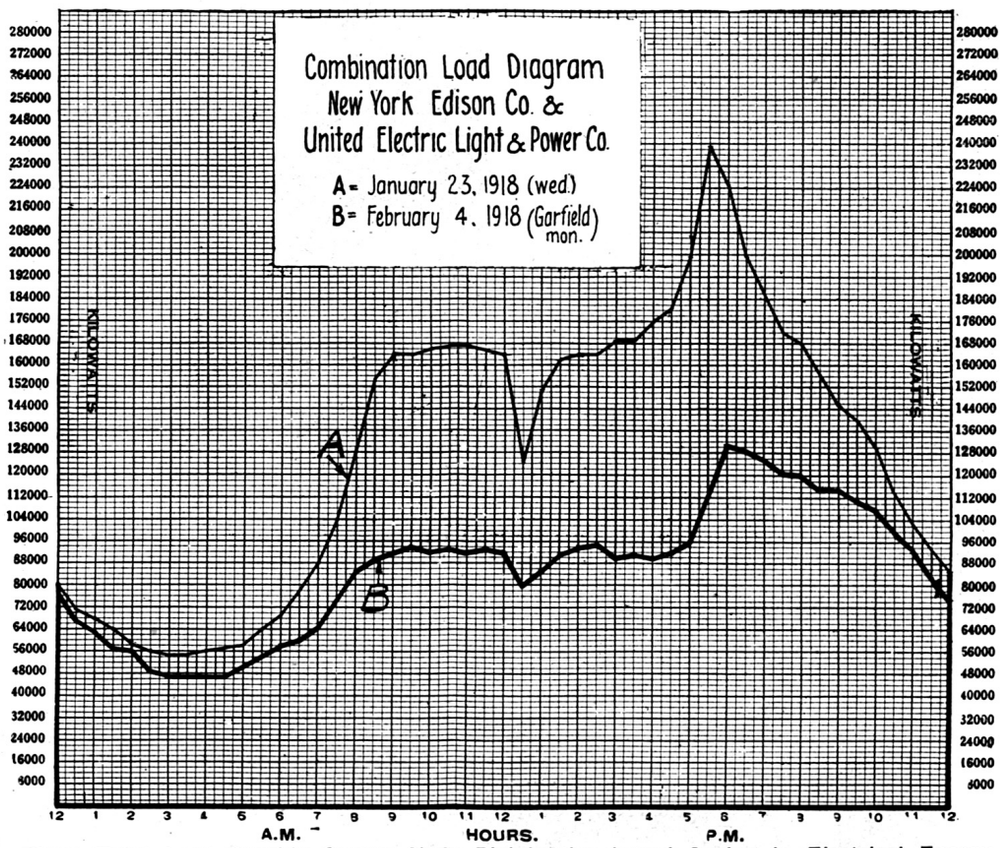


No! Radio-Hounds! It Is Not a Wireless Helix, But a Night Photo of the "Captive Aeroplanes" at Luna Park.

Horse-thief Pete, get out that kodak or plate camera. Dust her off and go shooting for that "odd photo." We know it's there, but as we can't travel all over the United States and thru foreign climes to ferret out these interesting subjects

Patriotism, Dr. Garfield, and New York

MANY persons have undoubtedly wondered just how patriotic the various sections of the country were during the recent "blue" Garfield Mondays, when the wheels of industry and business were closed down by official order. We are fortunate in being able to present direct evidence for at least one important case, that of New York City. The accompanying graphic curves show the total consumption of electrical energy in kilowatts for a period of 24 hours on two different days—one a heat-less, fuel-less, work-less day, and the other a normal day.



These Total Load Graphic Curves Show Plainly the Actual Saving in Electrical Energy Brought About in New York City Alone on a "Garfield" Monday, as Compared to a Normal Work Day.

The upper curve shows the consumption of electrical energy on Wednesday, January 23, 1918, and the lower, heavy line curve the amount of electrical energy used on "Garfield Monday," February 4, 1918.

As a glance at the figures and curves demonstrate clearly, the greatest saving effected on Garfield Monday, February 4, occurred at 5:30 P. M. in the evening, when the New York Edison Co. and the United Light and Power Co. *together* supplied about 112,000 kilowatts. At the same hour on a normal work-day, or on Wednesday, January 23, the "peak" of the load at 5:30 P. M. shows a total consumption of approximately 240,000 kilowatts, or the saving at the "peak of the day's load was 128,000 kilowatts, a saving of 53½ per cent.

From 12 o'clock midnight of Sunday, and on thru the early morning hours up until 7 A. M. Monday morning, the difference in electrical energy consumed on a typical Garfield fuel-less Monday, as compared to an ordinary work-day, indicates that only a slight difference was effected in electrical energy saved, or, on an average, about 8,000 kilowatts.

Proceeding from 7 o'clock in the morning, the saving due to the closing down of industrial plants, office buildings and stores is seen to swell rapidly until a saving of 74,000 kilowatts, or 44 per cent, took place at 11 A. M.

In the afternoon, Garfield Monday showed up about the same as the morning period, which might be expected in view of the fact that industrial plants, offices, stores, etc., were entirely closed down and the mean increase of about 10,000 to 12,000 kilowatts in the afternoon is due largely to the theatres, a considerable number of which gave special Monday matinees. The theatres were allowed to remain open Monday afternoon and night by Fuel Administrator Garfield, but were closed Tuesdays all day and evening.

As the evening of Monday approached, or at the hour of 6 P. M., the highest point of the day's load occurred, which for Garfield Monday was 130,000 kilowatts. As aforementioned, the total saving at the "peak" of the day's load due to the Fuel Administrator's order in closing all stores, except food and drug stores, besides factories and office buildings, amounted to 128,000 kilowatts saved, or 53½ per cent.

Curve "B" for Monday parallels on a lower level in general the contour of curve "A" for Wednesday, and the reason why this is so, particularly in the evening period, is because of the extensive street lighting and traffic power requirements in such a large city as New York. The evening load factor remained fairly large from 7 to 10 P. M. owing to the theatres and restaurants.

From this point the load graph continues on downward until it reaches the end of the 24-hour period coming under the Fuel Administrator's orders, with a total energy consumption of 74,000 kilowatts. After passing 12 o'clock midnight of Monday, the curve would continue to drop to about 54,000 kilowatts at 3 P. M.

Yes—New York City was quite patriotic!

AMONG the hundreds of new devices and appliances publisht monthly in the Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

"Edison Pioneers"

ON Jan. 2, 1918, a call signed by Messrs. Frederick A. Scheffler, Charles Wirt, Sidney B. Paine and William J. Hammer was sent to many of Mr. Edison's earliest assistants and associates requesting those who had entered his service before and including the year 1885, to attend a meeting at the Engineering Societies' Building, New York City, on the evening of January 24, 1918, with a view to effecting a permanent organization. The forming of such an organization had often been broached by the men who had been intimately associated with Mr. Edison and his interests at his famous Menlo Park, N. J. Laboratory, 65 Fifth Ave., (New York headquarters of the Edison Electric Lighting interests), the Edison Lamp Works, Machine Works, Underground Tube Works, and the various other commercial, engineering and manufacturing interests connected with Mr. Edison's electric lighting, telegraph, telephone, phonograph, electric railway and other interests in this country and abroad, and on Jan. 24, twenty-eight of Mr. Edison's early associates, shown in the accompanying illustration, met in the Board Room of the American Institute of Electrical Engineers, thru the courtesy of the Institute, and took the initial steps to form an organization to be known as *"Edison Pioneers."*

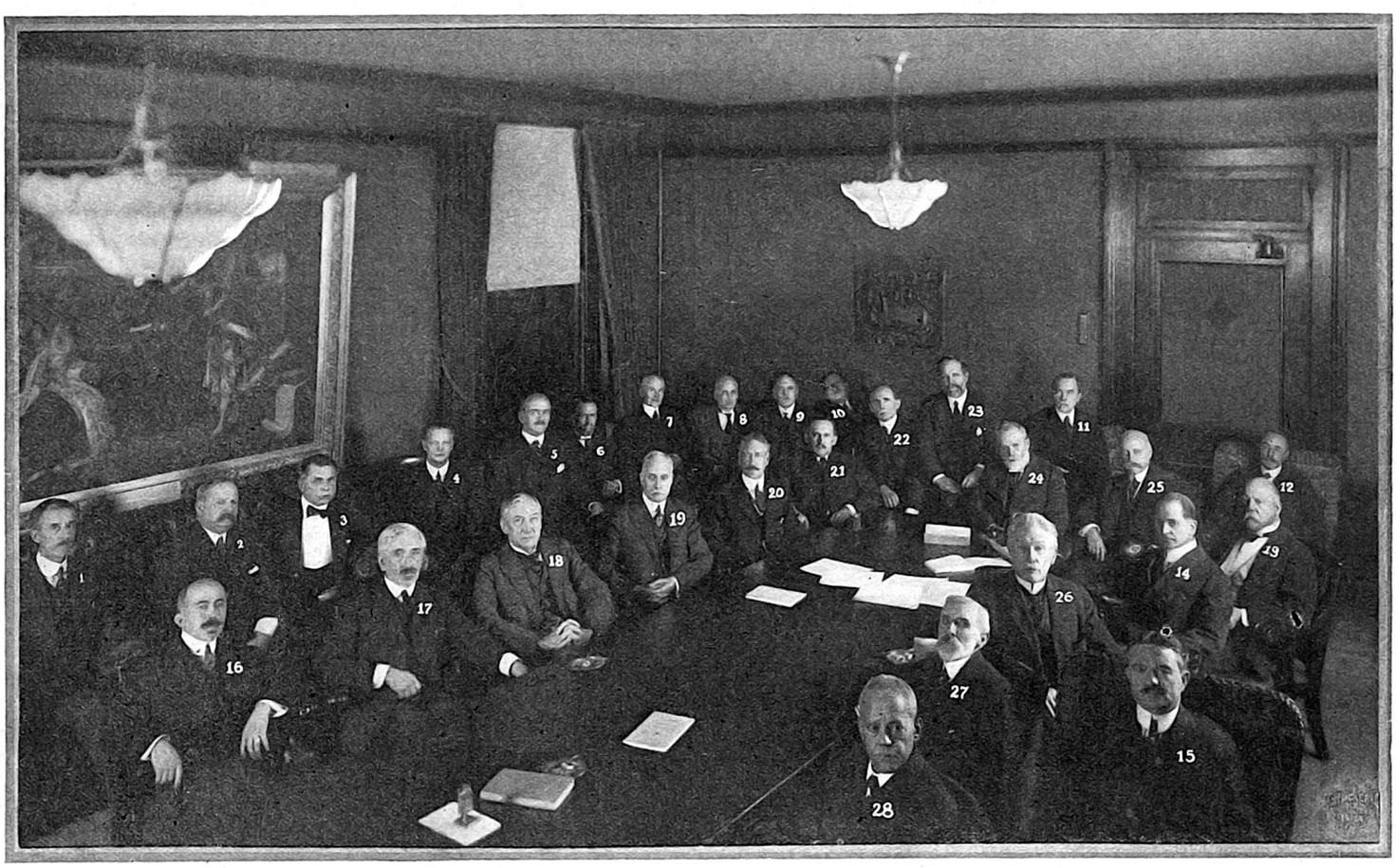
Thomas A. Edison and Miller Reese Hutchinson, His Chief Engineer, at a Meeting. Mr. Hutchinson Epitomizes the Proceedings and Taps a Report in Morse on Mr. Edison's Knee.

Many letters were read which had been received by men entitled to belong who were unable to be present, and who one and all approved of the movement and wished to be included. Others wrote requesting that the line of demarcation be drawn at various dates subsequent to 1885 so that they might be included, but it was decided that as perhaps one million persons have been connected directly or indirectly with Mr. Edison's various interests here and abroad, it was essential that the organization should at present be limited to the very earliest of those connected with the inventing, developing and commercializing of Edison's inventions, and later on taking in on some basis certain men whose work has been of most importance in Mr. Edison's later spheres of usefulness, such as the storage battery, moving pictures, etc., etc.

The following officers were elected: President, Francis R. Upton; vice-president, Samuel Z. Mitchell and T. Commerford Martin; secretary, Robert T. Lozier; treasurer, Frederick A. Scheffler; historian, William H. Meadowcroft.

Various committees upon organization, constitution and by-laws, etc., were appointed, and a telegram was sent to Mr. Edison apprising him of the formation of the *"Edison Pioneers"*, and after indulging in

(*Continued on page* 857)



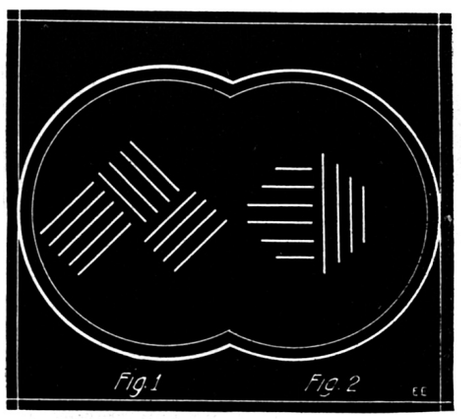
Left to Right: Back Row—1, Arthur S. Beves; 2, Charles A. Benton; 3, Dr. S. S. Wheeler; 4, Wm. M. Brock; 5, Howard A. MacLean; 6, H. A. Campbell; 7, Frederick D. Potter; 8, George G. Grower; 9, Frank A. Wardlaw; 10, Christian Rach; 11, E. W. Kiddle; 12, Sidney B. Paine; 13, F. S. Smithers; 14, Robert T. Lozier, Sec'y; 15, T. E. Crossman, Stenog. Around Table—16, E. W. Hammer; 17, Wilson S. Howell; 18, Charles S. Bradley; 19, Fremont Wilson; 20, Fred'k A. Scheffler, Treas.; 21, S. Z. Mitchell (V.-Pres.); 22, Peter Weber; 23, William J. Hammer; 24, Francis R. Upton, Pres.; 25, Cammerford Martin, V.-Pres.; 26, S. D. Mott; 27, William Carman; 28, E. H. Latimer.

COSMIC FORCE

By L. M. Correll

Engineering Department, Anaconda Copper Mining Company

AN inventor's recent claim of our ability to utilize the cosmic force has brought forth considerable conjecture concerning the meaning of such a discovery (referring to the claims of one—Garabed Giragossian, of Boston). "Cosmic" is defined as pertaining to the universe, universal or orderly,



One Form of Energy Made Up in a Certain Complex Form Would Have Its Own Characteristics, as Copper Might Have Ions Like Fig. 1, and Iron with Ions Arranged as in Fig. 2, Etc. This Probably Explains Why Different Materials Take a Definite Crystalline Form.

and "Cosmical Physics" as a term broadly applied to the totality of those branches of science which treat of cosmical phenomena and their explanation by the laws of physics.

The sun is considered as the source of all energy, which is conveyed thru space by a condition which, as far as we have been able to determine, is ether. These particles of energy in some form apparently shoot thru all space, altho it may be determined that the planets and other celestial bodies focus the sun's energy upon themselves by or on account of their own gravitational attraction. The earth is continually being bombarded by minute specks of energy from the sun, rather than by waves of any magnitude, which on passing thru the elements of the atmosphere enveloping the earth are transformed into light rays, heat waves and numerous other forms of energy, some of which we have been able to determine by recent scientific research. This conclusion has exploded the old theory that the sun gives off light and heat directly, which theory was indeed absurd, it having been assumed before the present electrical age and should be discarded, now that we have begun to see the "light."

An understanding of the first principles of cosmic force must first be secured, as this force is the power to be developed into our different requirements, and, as the principle is revolutionary to the old teachings it will be more clear to many if an example is cited. In ascending to a high altitude, as on a mountain, where there is a different atmosphere, i. e., an atmosphere which is more rare than at the lower altitude and therefore with less transforming effect on the form of energy received, the temperature of the atmosphere becomes colder and more noticeably so in the higher altitudes reached by balloons, and also it is noticeable that there is *less light*, regardless of the fact that they are constantly *approaching* the sun. Both light and heat diminish inversely as the square of the distance from their source, so that if the sun radiated both light and heat, the air should be at a much warmer temperature and more light should be given at the higher altitudes, which easily proves the fallacy of the older theory. If we consider the extreme distance of the space in which the energy in its true form must pass as it is propagated from the sun, it must arrive at the earth's upper strata of atmosphere with little or probably no loss of intensity. In its true term a minute speck of energy is used in the sense of a minute pulsation or vibration and not as a small particle of matter or substance.

Vibratory energy is classified according to the intensity and rapidity of its vibrations. The first evidence that we are able to recognize is sound, and, as the rapidity of vibration increases, to heat, electricity, light in its different colors is recognized, each color having a different rapidity of vibration. The human eye is not able to distinguish all colors of the spectrum, the rays below red on the lower scale and violet on the upper becoming invisible, but we know that some of these rays are seen by some birds and animals. This is about as far as our senses are able to discern these conditions unaided, as most of the higher order of vibrations cannot be studied directly, but only by witnessing the effect they produce under varying conditions, which are chemical rays, wireless or Hertzian waves, ultra-violet, X-ray, and thru research with radio-active material there have been discovered the alpha, beta and numerous rays of high frequency.

When calibration of the amplitude and velocity of all of these vibratory forms is perfected, a new field of research will be opened up which will have unlimited possibilities, as energy is not only in simple form but it is also in complex combinations. We may be able to take this energy as we receive it from the sun, calibrate it, pass it thru some element or substance, possibly an inert gas with a known resistance, and transform it into *all light* or *all heat*, as may be required, not unlike the method of transforming an electric current into a higher or lower voltage, or by the transforming of electrical current thru an incandescent lamp into light rays.

It has been estimated that the potential energy on the surface of the earth amounts to about 5,000 horse-power to the acre and numerous attempts have been made to apply a part of it to industrial uses by lenses, mirrors, etc., so as to concentrate the heat that has been already transformed by the energy passing thru the earth's atmosphere, to a point of application, but when we are able to transform all the energy into heat, then it will be a simple matter to produce steam, smelt ores and metals, and even serve for domestic use. When this is accomplisht, mining, transportation and the methods of use of fuel today for the same purpose will seem to be crude indeed. These are principles worthy of consideration, however advanced they may appear, for at any rate it is only a question of time until they will be developed, considering the wonderful strides made in their study in the last decade.

We may go even farther than this and actually demonstrate conclusively that matter is only a form of crystallized energy, directly related and a part of the cosmic force, and to our uses as a material, solely a creation of the mind. Scientists are approaching this principle thru the study of radium and radio-active material which radiate energy in forms that can be observed. Effects from such unstable molecules must not be considered as shooting off an electron, which is an infinitesimal particle of matter, thru some other element, but they should be considered as a speck of energy which passes as a vibration, not unlike sunlight in its passing thru a transparent substance like glass.

It has been verified that what we characterize as matter is a substance in a violent state of motion. Matter consists of molecules, atoms, ions and even a finer divisibility, all comprising a form of energy in a balanced state. When the balance or stability of an electron, atom or molecule is destroyed, a certain amount of energy is

(*Continued on page* 872)

TABLE OF VIBRATIONS

WHOSE EFFECTS ARE RECOGNIZED AND STUDIED

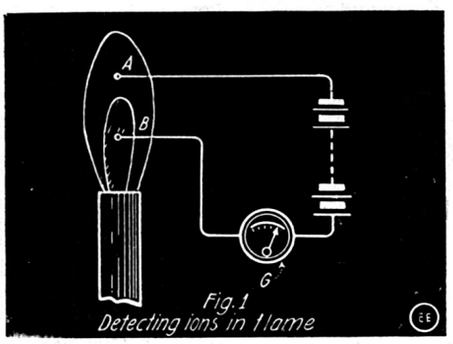
		Number of Vibrations per Second	
1st	Octave	2	
2nd	"	4	
3rd	"	8	
4th	"	16	SOUND
5th	"	32	
6th	"	64	
7th	"	128	
8th	"	256	
9th	"	512	
10th	"	1,024	
15th	"	32,768	
20th	"	1,047,576	UNKNOWN
25th	"	33,554,432	ELECTRICITY
30th	"	1,073,741,824	
35th	"	34,359,738,368	
40th	"	1,099,511,627,776	UNKNOWN
45th	"	35,184,372,088,832	
46th	"	70,368,744,177,644	HEAT
47th	"	140,737,468,355,328	
48th	"	281,474,976,710,656	
49th	"	562,949,953,421,312	LIGHT
50th	"	1,125,899,906,842,624	CHEMICAL RAYS
51st	"	2,251,799,813,685,248	UNKNOWN
57th	"	144,115,118,075,855,872	
58th	"	288,230,376,151,711,744	X-RAYS
59th	"	576,460,752,303,423,488	
60th	"	1,152,921,504,606,846,976	
61st	"	2,305,843,009,213,693,952	
62nd	"	4,611,686,618,427,389,904	UNKNOWN

The Phenomena of Electrical Conduction in Gases.

PART I. WHAT IS IONIZATION?

By Rogers D. Rusk, M.A.

A FEW years ago scientists were so busy studying currents of electricity in wires and liquids that they thought very little about currents of electricity in gases. In fact, up until 1880, it was supposed when an electrified body lost its charge in the air that this was due only to dust, or moisture in the air, and to faulty insulation. Now we know that



Simple Experiment by Which It Becomes Possible to Detect "Ions" in a Flame. Due to the Ions Formed in Such a Flame, It Conducts an Electric Current, as the Galvanometer Proves.

the molecules of the air or a gas may themselves act as carriers of electricity and thus conduct the charge away in addition to the other factors mentioned.

This idea has been much more revolutionary than most people suspect. It has helped us to completely change our ideas of matter thru what we have learned of these molecular carriers of electricity. It has helped us to discover marvels as great as in any scientific field, as for instance the production of light without heat by ionization. It has given us the Audion and all similar detectors useful in wireless telegraphy, which are applications of what is called the *Edison effect.* Beyond all this it has given us, more than any other field, facts which substantiate and prove the *electron theory of matter,* and universal nature of electricity.

The field of ionization in gases is truly a Twentieth Century branch of science because only since 1900 has it been studied as a separate field in itself. Unlike most branches of Physics and Electricity its youth keeps it from having reached the degree of complication and mathematical complexity usually to be encountered. Neither is the history of the study of ionization in gases long or involved nor is it buried under mathematical formulae. Brilliant experiments are often accomplisht with simple apparatus, and for these reasons and for the things of the future which may be expected, it seems that a study of this field should prove doubly interesting both to the tyro in scientific matters and also to the professional scientist.

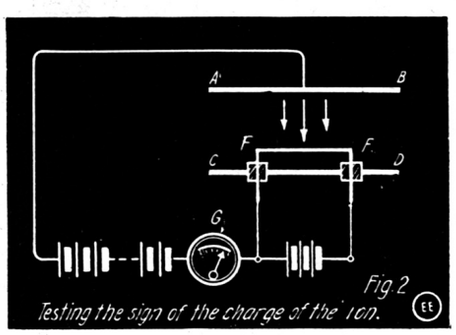
By ionization is meant that change in a non-conducting gas or liquid which renders it conducting. Evidently this may be effected by either the molecules of the conducting medium, splitting up, remaining single, or grouping themselve together in little clusters, and then acting as carriers for positive or negative charges. It is common knowledge that in liquids the molecules break up into two parts carrying equal and opposite electrical charges, and these ions travel in opposite directions toward their respective electrodes, and thus carry the current from one pole to the other. The same thing is true in gases except that the ions do not slide along as in a liquid but fly thru empty space, colliding with each other frequently, and zigzagging along. Also in the case of gases we may have parts of molecules, whole molecules or groups of them acting as the carriers, depending on conditions.

It is because of these ions which are formed in a flame that a current of electricity can be made to jump a gap between metal points, if a flame is held between them. In Fig. 1 a device is shown for testing the electrical conductivity of a flame by means of a galvanometer. When the flame comes in contact with the points A and B a swing of the galvanometer needle will denote a current across the gap AB.

In the same way and due to the presence of ions, a current will pass thru air or a gas upon which has fallen X-rays, ultra-violet light, or the rays from radio-active substances. For the same reason, too, a current will pass in an Audion bulb from the plate to the filament.

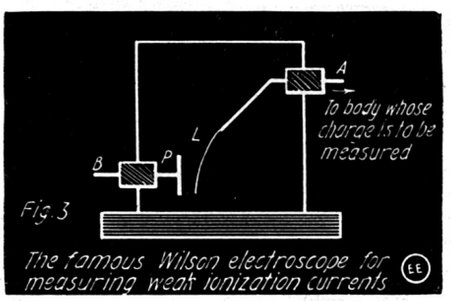
In order to understand properly where the study of ionization begins it is necessary to note the high points of experimentation which have brought us up to our present position. Faraday, the great pioneer electrical student, disclosed the keenness of his scientific insight in a statement which he made about 1840 when he was studying electrical sparks in different gases, in which he says the idea came to him that there was *"A direct relation of the electric forces with the molecules of the matter concerned in the action."* Faraday saw that the molecules of the gas, themselves, had something to do with the action, but little came of his suggestion for a long time. In 1879, Crookes arrived at the startling conclusion that cathode rays were minute charged particles of matter, and soon after the discovery of the X-rays, in 1895, the cathode particle was named the *electron* and actually measured in mass and charge by many investigators including J. J. Thomson. These fact led J. J. Thomson, along with E. Rutherford, his co-worker, to formulate the *ionization theory of gases* which is now universally accepted, and which assumes that the molecules of matter themselves act as carriers for the charges or electrons.

One of the first things to be noticed in the study of ionization is that under some



By Means of This Apparatus the Investigator Is Enabled to Test Various Chemicals to Determine What Kind of Ions Are Given Off—i. e., Positive or Negative.

conditions immense numbers of positive ions may be present and very few negatives, while under other conditions exactly the opposite may take place. This, of course, would have been entirely impossible in liquids where always the same numbers of negatives and positives are present. Investigation has shown that different solids give off different kinds of ions, when heated, and that even the same solid may give off different kinds of ions when heated to different temperatures or surrounded by different kinds of gases. For instance, the nitrates of calcium, strontium, and barium give off negative particles or electrons when



This Form of Extra Sensitive Electroscope Was Devised by Wilson for the Purpose of Detecting and Measuring the Minute Electric Currents Due to Ionization.

heated, while on the other hand aluminium phosfate gives strong positive ionization. A mixture of one of the nitrates and aluminium phosfate gives off both kinds of ions. Anyone can easily test various chemicals to see what kind of ions are given off by use of an apparatus as shown in Fig. 2. AB and CD are the sides of a metal tube in which a wire filament FF is led thru insulators. The filament FF is coated with the compound to be examined and then heated to incandescence by means of a suitable battery. A galvanometer and auxiliary battery are bridged around the tube and the filament so as to complete the circuit thru the galvanometer across the air gap between the filament and tube. If the filament gives off negative ions or electrons the current will pass in the direction of the arrow but not in the opposite direction. If the ions given off are positive the reverse is true. The auxiliary battery may be reversed in either case to complete the test.

For such work the ordinary galvanometer is not found as sensitive as is often desired and usually an electrometer or some form of electroscope is used. Frequently, instead of measuring the current across an air gap, a charged body is placed in the presence of the ions and the rate of leak of its charge is taken as an indication of the strength of the ionization. In such work the field of static electricity renews its practical value and the old gap between static and current electricity almost disappears.

It used to be thought that static electricity was more or less of a plaything only, and that the electroscope was useful only in demonstrating simple facts about electrification, and was not an instrument of scientific precision. Now, in improved forms, it is one of our most sensitive instruments and is one of the most common employed in measuring minute quantities of electricity, especially ionization currents. The form of the ordinary gold leaf electroscope is familiar to everyone, but some of the more improved types do not resemble it very much, altho they work on exactly the same principle. The form of the Wilson electroscope, one of the most sensitive types, is shown in Fig. 3. Two electrodes are led into a

(*Continued on page* 876)

NEW PORTABLE ELECTRO MEDICAL APPARATUS.

The beneficial effects of electrotherapeutic treatment are coming to be so generally recognized that a large demand has arisen for simple and reliable equipment by which it may be applied by the ordinary layman. Especially is this true with high-frequency apparatus, which gives an invigorating and perfectly safe as well as pleasant treatment found very satisfactory by physicians, chiropractors and beauty experts for many ailments and for toning the tissues and nervous system.

The accompanying illustration shows a combination cabinet and wall plate for physicians' use. It provides in one compact set for the four treatments commonly used in electrotherapeutics, namely, galvanic, faradic, high-frequency and sinusoidal currents. It includes a cord for connecting to the ordinary lighting circuit, an adjustable induction coil, a rheostat, a Tesla coil, a milliammeter, two lamps for illumination and resistance, a spark gap, special electrodes or applicators, connecting cord, terminals, etc. Ease of adjustment is provided for in every detail. Means are also arranged for connecting and regulating diagnostic lamps.

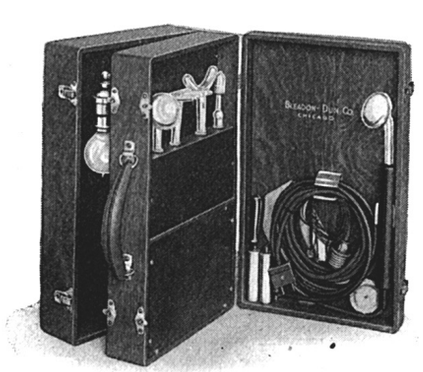
This outfit is mounted in a portable and handsome oak case, measuring only 16 by 10 by 7½ inches. It can be carried like a suitcase, or quickly mounted on the wall.

The *galvanic current* is produced without the aid of dry cells and at all times the current is smooth, steady and even. The slightest change in the current is immediately communicated to the sensitive milliammeter mounted on the face. The current can be regulated to any degree of strength and will be maintained so to any desired time.

The *faradic current* is produced by the faradic coil mounted beneath the milliammeter. The core of this coil is made of annealed Norway iron wire, which insures greater magnetic saturation than the solid core. The primary and secondary winding are wound in exact proportions in order to give absolute resonance.

The *high-frequency current* is produced by the same coil in conjunction with a Tesla coil. The High-Frequency current is regulated by means of a spark gap mounted underneath the coil and also by the knob regulator on the coil itself. The knob regulator controls the vibrator spring. The current can be decreased from a spark of over three inches to such a fine current as to be almost imperceptible; at the same time maintaining its smooth, even flow.

The various electrodes are attached to a small handle which is very convenient. The cord from the instrument to the handle is of pure gutta percha.



Unique Portable Electro-Medical Set For Private or Physicians' Use.

The shunt rheostat regulates the voltage and intensities of the different currents. It is wound to a high resistance and is claimed not to deteriorate or heat.

AN ELECTRIC MAGAZINE SOLDERING IRON.

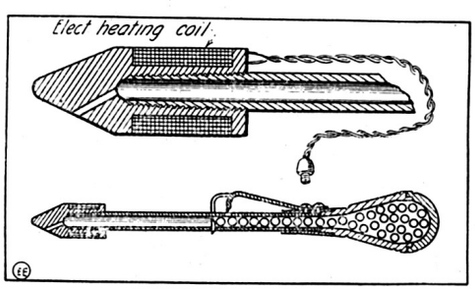
A clever magazine soldering iron has been patented by Ray M. Tilton, of Panora, Iowa, which possesses several desirable features. One object is to provide a magazine soldering iron having a hollow shank connected with a handle at one end and a soldering iron member at the other end, with means for controlling the passage of particles of solder thru the shank.

The top finger extends above the shank and outside said shank, as shown, whereas when the two arms, which stand side by side, are prest toward the shank, the upper finger extension enters the shank while the lower finger leaves the shank.

The two arms are so arranged as to be rigidly engaged by the thumb of a person whose hand grasps the handle. The upper and lower metal fingers are spaced apart such a distance longitudinally of the shank, that between them is the proper space to receive a small pellet of solder.

In the practical use of this improved soldering iron, the handle and the portion of the hollow shank adjacent to the handle is filled with solder pellets, when the cover is removed. One arm normally holds the lower finger in position so that the pellets are moved toward the point of the iron.

By pressing the two spring arms toward the shank and holding the entire device in the proper position, the pellet nearest the iron will be permitted to roll downwardly into the iron, where it will be heated and melted, and will flow thru the narrow passage shown to the exterior of the iron.



New Magazine Soldering Iron—the Solder Pellets Are Held in the Handle. A Finger Trigger releases the Pellets as Required.

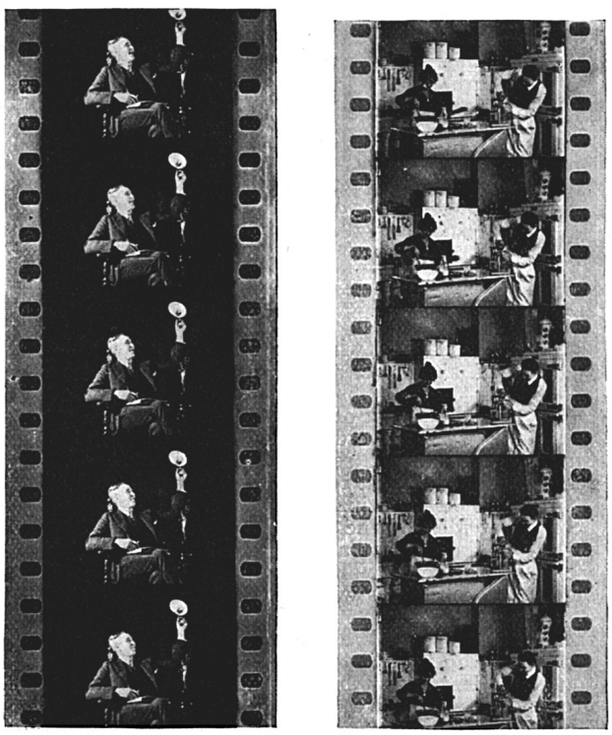
INDIANA TOWN BECOMES DARK WHEN CITIZEN TAKES BATH.

For the space of one minute all the lights in Marion, Indiana, recently went out and all institutions depending on Marion current for operating were stilled, all because John Coats, while taking his regular Saturday evening bath at his home, got hold of a live wire, in attempting to shake into life a defunct electric light globe and could not let go.

Standing in the water with 110 volts coursing thru his body, all Coats could do was to yell for help. A neighbor quickly discovered Coats' plight and telephoned the light company, which turned off all the current. Mr. Coats was in a serious nervous condition for some time afterward, but suffered no serious injury.

"MOVIES" HELP TO PUSH ELECTRICAL SALES.

The "movie" is the greatest salesman in the world today—a merchandising method considered to be between 95 and 100 per cent efficient because, says the *Society for Electrical Development*:—1. It gets the undivided attention of its entire circulation. 2. It interests everyone because it's a movie—a story—because it is life itself, the most interesting thing in the world. 3. It "gets over" a selling argument more thoroly and effectively than a human salesman possibly could—and to hundreds of persons in a few minutes!



In the "Movies" They Do It—Electrically Chop the Food, Fry the Eggs, Etc., All For the Purpose of "Educating" the Public.

In other words, an entire sales argument is comprest into a few feet of film—an argument which would take hours to explain, and pages and pages to describe—and not near so convincingly!

"The Home that Runs by Magic" is the title of one very interesting "Universal" motion picture, which emphasizes the fact that the modern home is electrically equipt thruout and that the labor of housekeeping is appreciably lightened by the use of electrical appliances.

It is a heart-interest story about a young bride whose husband gives her an All-Electric home. The first scene shows them riding up to it in their new Electric Car. Next you see them at breakfast using their Table Appliances—then getting dinner in their Electric Kitchen. Next wifie makes wash day Wash Hour in her Electric Laundry. Other similar scenes follow. The picture vividly demonstrates the utility and comfort of Electric Appliances and drives home their practical appeal this year. It shows in actual operation: Toasters, Grill, Warming Pad, Percolator, Electric Car, Flat Iron, Samovar, Radiator, Floor Lamp, Electric Range, Kitchen Utility Motor, Washing Machine, Electric Refrigerator and Drink Mixer.

These films are available at a nominal figure, and are run in the electrical contractors' home town "movie" theaters. This scheme is both instructive and educative as to the ways in which electricity can be used in daily life, besides being a mighty good booster of electrical sales.

Utilizing Burnt-Out Lamp Bulbs

By H. Gernsback

HOW can we utilize burnt-out electric lamp bulbs? Almost everybody has several of these lying around idle. For the purpose of having the household as well as the experimenter make use of such discarded bulbs, the present article has been prepared.

We will pay until further notice monthly prizes as follows: **First prize—$3.00** *for best suggestion;* **Second prize—$2.00; Third prize—one year's subscription to the ELECTRICAL EXPERIMENTER.** *Every reader may join in this contest, and you need not be a subscriber to participate. Ideas will be publisht monthly under the head of* **"Burnt-out Lamp Contest."** *All letters should be addrest to "Editor,* Burnt-out Lamp Contest."

EVERYBODY who has electric light has, as a rule, a good many burnt-out lamp bulbs lying around idle which are not of any use, and sooner or later are discarded or perhaps thrown at nocturnal song makers on the fence, with indifferent results to the singer.

The thought of utilizing such bulbs had been a pet idea of the writer's for a long time, and the present article, and the ones we hope will follow, aim to save these old bulbs. The few ideas which we illustrate in the present article do not, of course, cover the whole subject. We are quite confident that there must be hundreds of other uses for the burnt-out bulbs, and we hope to present in our future issues further—and better—ideas of our ingenious readers.

The applications shown in Figs. 1, 2 and 3 are rather old, and are merely shown in this article to make it more complete. The other ideas were evolved by the writer and are supposedly new.

Fig. 1 shows how an excellent barometer, that will correctly predict changes of the weather, can be made from an ordinary lamp bulb. Take a burnt-out lamp, it matters not whether it is of the Tungsten or carbon variety, and place it in a basin of water, tip down. Now, by means of a heavy, sharp pair of scissors, cut off the glass tip, *while holding the lamp under water.* The use of pliers is not necessary, and the scissors will not be damaged by cutting glass under water. Be careful that when cutting off the tip not too much is cut off; *just a very little will do.* Immediately upon cutting the water will rush into the bulb with a violent boiling effect.

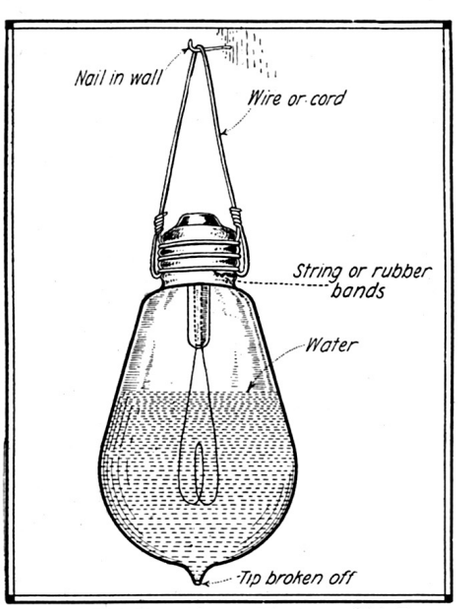


Fig. 1. Did You Know That an Old Burnt-out Lamp Bulb Makes an Excellent Weather Predictor? No? Here's How.

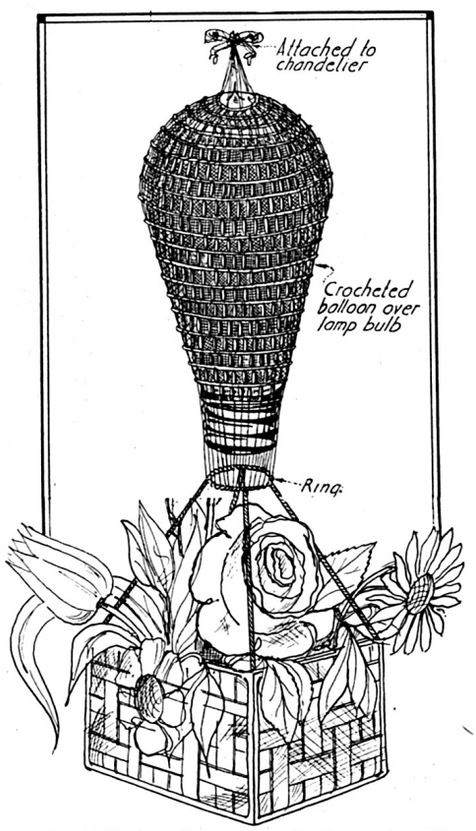


Fig. 2. Utilizing Burnt-out Bulbs and Utilizing Ma and Sis to Crochet Artistic "Balloons" for the Parlor Will Soon Be the Rage. Colors, of course, Red, White and Blue!

It takes but a few seconds to fill the bulb almost full. When taking the bulb from the water, contrary to expectation, the water will not flow from the small aperture at the former tip of the lamp. We now take the lamp and fasten a wire or cord around the screw part, so that the lamp is suspended tip downward (see illustration).

When the weather is fair for several days, no water will issue from the tip of the lamp. If, however, rainy weather impends, a drop of water will be observed at the tip, and it is quite surprising that a simple barometer of this kind will actually predict rain or fair weather twelve to twenty-four hours ahead of time. After a while, particularly, if there is much rainy weather, the bulb will become empty, as sometimes a few drops of water will come out of the bulb. This does not necessitate the throwing away of the bulb, and the writer has found a simple means for refilling it. Heat the bulb over a hot fire so that it becomes quite hot, then plunge into a pan of *hot* water, and the water will rush into the bulb filling it about three-quarters. Inasmuch as ordinary water is colorless, the writer suggests putting a coloring matter in the water before filling the bulb, which not alone makes the device more attractive, but at the same time makes it more easy to observe the tip when the water leaves it.

Our next illustration, Fig. 2, shows a simple device which you perhaps have seen already. This is something for the ladies, and particularly those who like to knit or crochet. An ordinary lamp bulb is decorated with red or other colored silk crochet work as illustrated, the idea being to form a balloon. Directly underneath the screw part of the bulb, an iron ring which may be a small key ring is located, which may be crocheted over. This ring is suspended from the bulb by means of silk threads as shown. The ring itself in turn supports the crochet basket or the car, which latter may be used to hold artificial or real flowers, as may be desired. Our illustration shows this accurately. At the top of the lamp a stout silk cord is sewn, and the whole may be attached to the chandelier in the parlor, or dining room lamp, giving a very pretty effect.

In illustration No. 3 is shown how the average experimenter can make small chemical vessels for experimental purposes, simply by using only the glass part of discarded lamp bulbs. One illustration shows a wooden block with wire work and handle on the style of soda fountain tumbler-holders, while the other illustration shows a similar idea, but here the holder is made of wire only. The lamp bulb may be cut by means of a three-cornered file, and it is safe to first break off the tip of the lamp to let the air in. This makes the cutting safer. The tip may afterwards be placed in a Bunsen burner to seal up the small hole which, of course, is necessary, otherwise liquids or acids would run out from

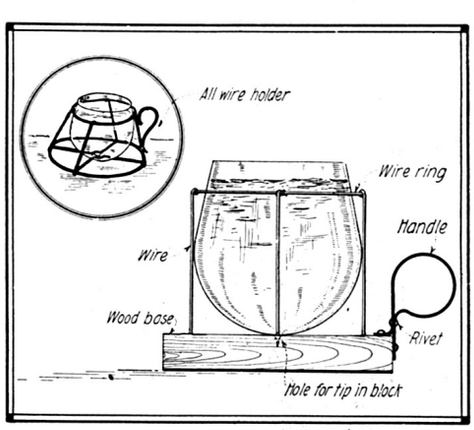


Fig. 3. No, Ma'am, This Is Not a Soda Water Glass. It's Used in Your Young Hopeful's Chemical Laboratory. Yes, It's Made from a Burnt-out Bulb.

the improvised chemical vessel. Another way to cut the lamp in case no file is had, is by taking a heavy string of cotton cord,

soaking it in alcohol and wrapping it two or three times around the point where the bulb is to be cut. Hold the bulb in the hand and light the cord with a match. After all of the alcohol has burnt out,

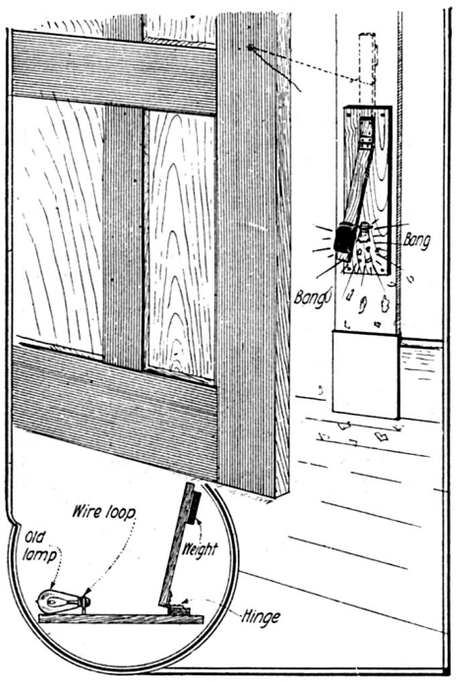


Fig. 4. Scaring "Burgulars" to a Quick Horrible Death by Means of an Old Burnt-out Lamp Bulb Is Not Such a Horrible Idea as It "Sounds."

dash a drop of water against the heated part where the cord was previously, and as a rule a clean cut will result.

Fig. 4 shows an improvised burglar alarm of the writer's, and it goes without saying that the very nature of this makes it impossible to use it more than once, but the writer guarantees that it will give a bad scare to any burglar who would attempt to open a door thus "protected." The idea simply consists of a board on which the lamp bulb is mounted by means of a wire loop. Of course, the bulb should still have its vacuum. Another piece of wood is secured by means of an ordinary hinge, and this piece of wood at the lower end is weighted by means of a piece of metal or stone or anything else that comes in handy. The entire outfit is now hung at the door frame while a thread is attached to the hinged part carrying the weight. It is apparent that as soon as the thread is broken, while opening the door, the weight will smash the bulb with a loud report. The thread itself is fastened by means of a special staple or tack to the door as shown in illustration. One or two feet of thread will do nicely. Of course, this alarm can be used again by putting another lamp in place.

Here is a medicated vaporizer or room fumigator that can be made by anyone at very little cost, Fig. 5. Take an ordinary lamp bulb and break off the tip, then cut off a small part at the top as shown. This you can do by means of a file or otherwise with a diamond. For that matter any glazier will do it for you for a few cents if you do not care to do it yourself. Break off all the filaments, leaving only the two lead wires exposed, as shown. Fill the bulb with either of the formulae as given below, all depending on the purpose for which you wish to use it. Fill the bulb as shown, and connect to your light supply. No resistance of any sort is required. Within a few seconds the water will begin to boil, while fumes will issue from the top of the bulb. Formula No. 1 has been prepared by a well-known physician and is excellent in case of colds, extensive coughing, cases of hooping cough, etc. Formula No. 2 will fumigate any room very quickly. The writer recommends both formulae. The beauty of this device is that *it works entirely automatic* for the simple reason that as soon as the liquid has evaporated below the level of the two lead wires, the current is turned off automatically, and no more fumes are generated. It is therefore entirely safe to leave this device run once it is started. It will stop at once as soon *as enough liquid has evaporated.*

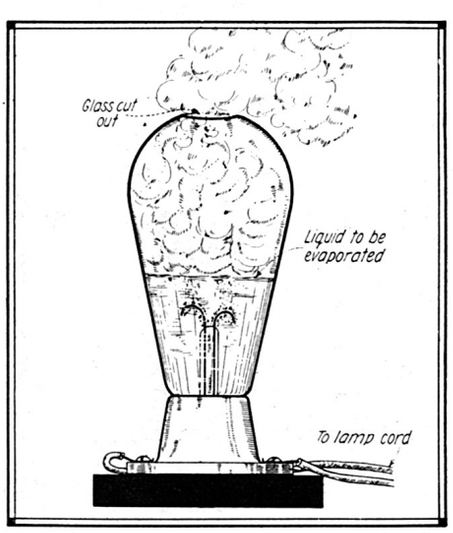


Fig. 5. Whoever Heard of Curing a Cold or Croup, or Disinfecting the House, With a Burnt-out Bulb? No, You Don't Eat the Bulb —But You Vaporize the Medicated Liquid!

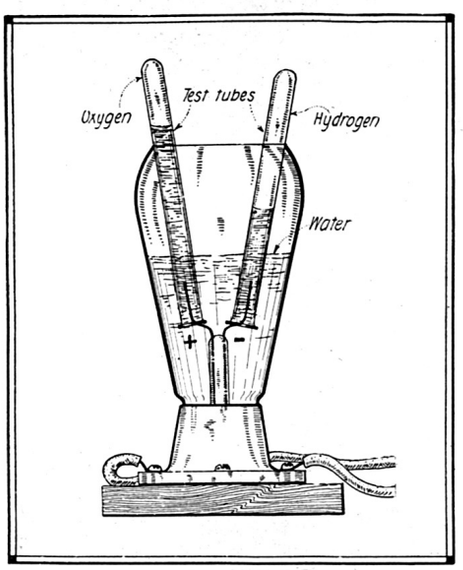


Fig. 6. This Shows How You Can Make at Practically No Cost a Very Efficient Apparatus for the Decomposition of Water—Electrolysis.

FORMULA No. 1.

For Colds, Coughs and Croup.

Oil of Eucalyptus..... 60 drops
Menthol ..... 60 grains
Tincture of Benzoin compound
(enough to make 2 ounces)

Of the above, use 1 teaspoonful floated upon water in vaporizer. Add a pinch of salt to make solution conductive.

FORMULA No. 2.

For Fumigating and Disinfecting.

Have druggist make a 40% solution of formaldehyde. Add a pinch of salt to make solution conductive. Use without diluting in vaporizer. This solution is excellent for killing flies and mosquitoes, and is to be operated in closed rooms without any people being in the room at the time of the fumigation.

Nearly every student wishes a cheap as well as good instrument to demonstrate electrolysis—decomposition of water. These instruments are more or less expensive in the market, and as a rule a student does not wish to bother by buying one of them, as they sell in the neighborhood of three to five dollars each. In Fig. 6 the writer has shown how one of these instruments can be made for practically nothing. All we require is a burnt-out electric lamp bulb. Any size will do. Proceed as explained in the preceding article of the vaporizer, as far as cutting off the top of the bulb is concerned. Leave the two lead wires exposed as shown. Fill the bulb with diluted sulfuric acid, five parts of water to one part of sulfuric acid. Over each one of the wires place a narrow diameter test tube, which test tube must be full of electrolyte, which can be done readily by filling them first, and while holding a finger over the open part insert in the bulb filled with the diluted acid. This will keep all the liquid in the test tubes, which is quite necessary. Both test tubes of course should be full. Now that everything is ready, connect the apparatus to a source of current, such as a six-volt storage battery or six good dry cells. It is understood that the bulb thus prepared is screwed in a porcelain receptacle as shown. As soon as the current is turned on you will see gas bubbles arise in each one of the test tubes, and you will observe that the gas accumulates twice as fast in one tube as in the other. The first tube, which contains the most gas, will con-

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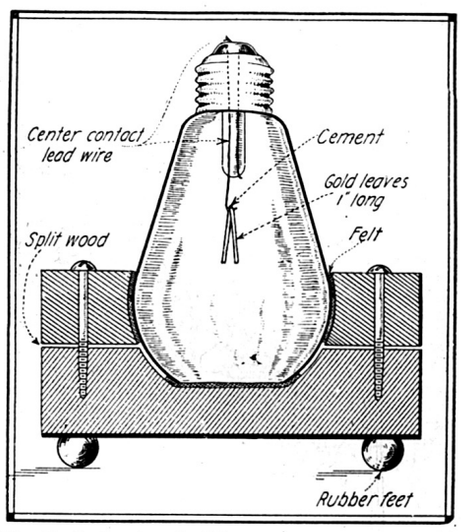


Fig. 7. A Student's Electroscope from an Old Burnt-out Lamp Bulb? Why Not? Very Simple if You Know How.

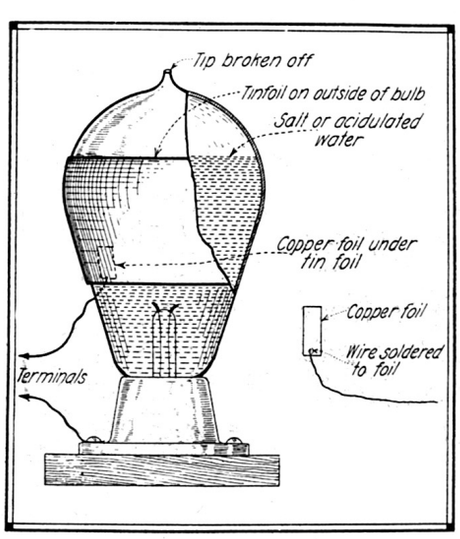


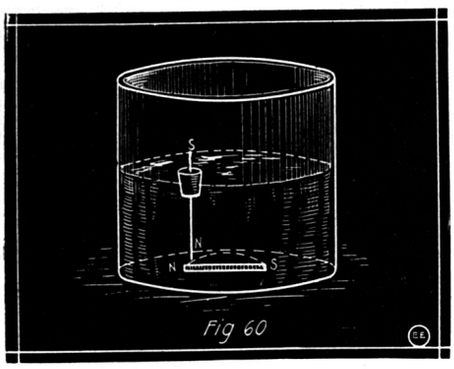
Fig. 8. Making an Efficient Condenser by Means of an Old Lamp Bulb is Quite a Simple Matter.

EXPERIMENTAL PHYSICS

By John J. Furia, A. B., M. A. (Columbia University)

LESSON 12.
Magnetism.

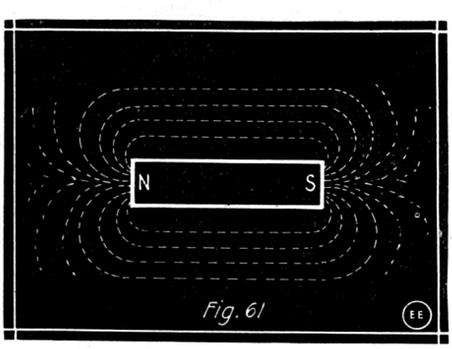
A CERTAIN kind of iron ore has the power of attracting iron (and cobalt and nickel somewhat). When a piece of it is suspended so as to swing freely it will come to rest in a north-south direction. This



An Interesting Experiment With a "Floating Magnet"—A Magnetized Sewing Needle Thrust Thru a Cork. "Like" Poles Repel, Hence the Needle Will Float Over to the "S" End of the Bar Magnet.

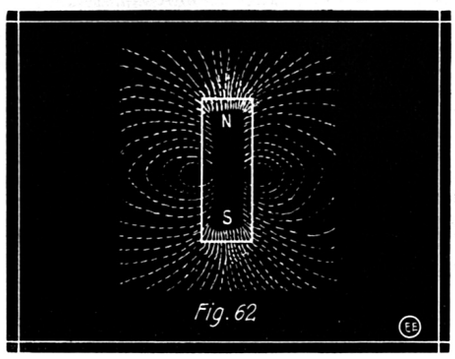
ore, called *lodestone, iron oxid* or *magnetite,* from Magnesia (not citrat, but a town in Asia Minor, where it was first discovered), is also known as the *natural magnet* to distinguish it from the *artificial magnet.* If an ordinary steel needle is brought near some iron filings it will not have any attraction for them; and if it be suspended freely it will not, in general, assume a north-south direction. If, however, this needle is gently stroked over a natural magnet (a bar or horshoe magnet will do) from the middle toward the point, it will now attract iron filings and assume a north-south position when suspended so as to swing freely; i. e., it has become an *artificial magnet.* If, instead of a steel needle, a piece of soft iron is used we find that it does not become a permanet magnet, but if the bar or horseshoe magnet is held over it or in contact with it the soft iron does become a magnet (temporarily, while the magnet is held near). Hence pieces of soft iron can be made to act as *temporary magnets,* while pieces of hard steel retain their magnetism to a great degree and can hence be made into *permanent magnets.*

It has been agreed to call the end of a magnet which, when swinging freely, points to the north the + or *north-seeking* pole, or more simply the *north* pole of the magnet, and the other end the — or *south-seeking,* or *south* pole. The ordinary compass is a small light bar magnet (needle) balanced upon a sharp pivot.



Representation of a Few of the "Lines of Force" Existing About a Steel Bar Magnet.

EXPERIMENT 66—Magnetize a needle by stroking it a few times with a bar or horseshoe magnet. Bring the needle up to a small compass. One end of the compass will be attracted to the needle. Turn the needle around and bring it up to the compass again. Now the other end of the compass is attracted. By suspending our magnetized needle, we can determine which end is + or north and which is — or south. We find that the + end of the needle attracts the — end of the compass, and vice versa; i. e., *unlike poles attract.* If now we bring the + end of the needle near the north pole of the compass or the — end of the needle near the south pole of the compass, we find that they *repel* each other, i. e., *like poles repel.*



Fully Developed Magnetic Field of Force Around a Bar Magnet. The Greatest Strength of Field is Manifested at the Ends of the Bar, Where the Flux is Most Dense.

EXPERIMENT 67—Place a compass so that its needle points to its north (N) point and then place the + end of a bar magnet one inch from the "W" point of the compass and note the deflection of the compass needle. Now move the bar magnet so that the + pole is two inches away. The deflection is found to be only *one-fourth* as much as before. If we move the bar

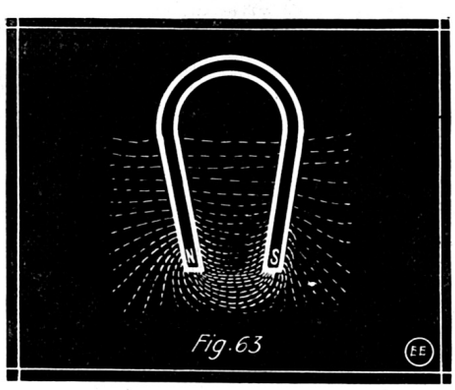
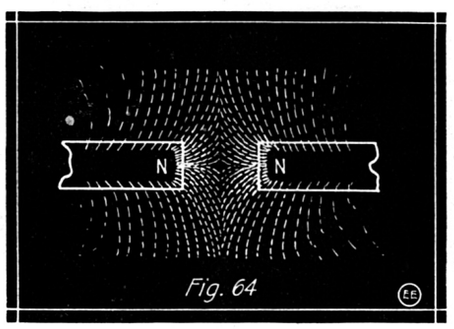


Chart of the "Lines of Force" About the Poles (and Between Them Also) of a Horse-Shoe Magnet. The Leakage Flux Between the Legs of the Magnet is Clearly Shown.

magnet to three inches from the compass "W" point, we find the deflection of the compass needle *one-ninth* as much as the first reading. If, while at any one of these positions, we add another magnet (same pole) the deflection is doubled, and if two are added the deflection is tripled, etc. This illustrates the *law of attraction (or repulsion),* i. e., *the force varies directly with the strength of the magnets and inversely as the square of the distance between them.* (In this experiment we increased the strength by adding more magnets.)

EXPERIMENT 68—Magnetize a long, thin needle and stick it thru a cork. Place the cork in a wide jar (or fish globe) filled with water. Place the jar over a bar mag-

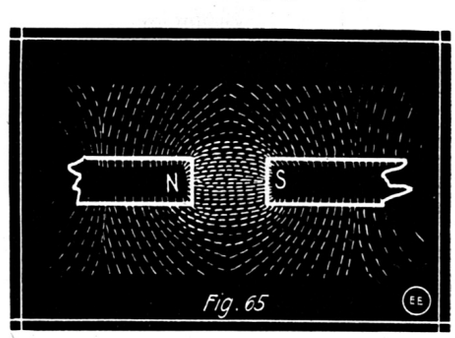


Showing the Field of Magnetic Force Resulting from Approaching Two "Like" (N) Poles Together. One Pole Neutralizes the Flux of the Other Pole and "Repulsion" Results.

net (see Fig. 60). When the N pole of the needle is placed over the N pole of the magnet it will be found to travel over to the S pole in a curved path. On starting the cork from different positions it will repeat as above, following different paths. The path which a free N pole travels over, when placed over the N pole of a magnet, is called a *line of force.* Obviously there are an infinite number of such lines, and these as a whole are called *fields of force.* From what we have said so far it is apparent that a free N pole cannot exist, but recalling that force of attraction (or repulsion) varies inversely with the square of the distance, we see that the long needle acts as a free pole (its other pole being so much further away from the bar magnet). Fig. 61 shows several *lines* in a *field of force.* A good way to obtain a field of force is to place a magnet under a sheet of paper and sprinkling iron filings over it. The filings arrange themselves along the lines of force. A permanent record of a field of force can be obtained by using photographic paper (working in a darkroom), sprinkling the filings, tapping the paper, lighting a match about a foot above the paper and then developing as one would a photographic print. (See Figs. 62, 63, 64, 65 for some typical fields of force.)

EXPERIMENT 69—Suspend an unmagnetized needle by a thread so that it hangs horizontally. Now magnetize it. It will be

(*Continued on page* 876)



The Couplet of Magnetic Power — When Two "Unlike" Poles (N and S) Are Brought Together, "Attraction" Results. The Two Magnets Are Drawn Toward Each Other. Compare With Fig. 64.

Editor's Mail Bag

Under this heading are publisht communications from our readers of general interest to all concerned. In order that letters shall receive proper attention, we earnestly request you to make them as short and concise as possible. This is essential and on account of the great amount of mail received daily.

No attention can be paid to unsigned communications, but on request we will withhold the correspondent's name.

A CURIOUS EXPERIMENT.

Editor Electrical Experimenter:

I read the "E.E." and like it. I believe the more one knows about the "game" the better he likes it.

Here is a little experiment or rather an experience, that may occasion a smile, but laugh as you please, it *is* a fact.

I was moping around the house, after an illness of several weeks. My attention was attracted by the beautiful colors of the spectrum which were playing on the white kitchen wall. I soon discerned the cause. An August sun was streaming thru a window and the rays impinged on a bevel edged mirror that had once ornamented the top of a ladies' work box. At last tired of the color effects I took the glass and went to the rear porch and amused myself with the old boyhood trick of "shooting" distant objects, with the sunlight "gun." Now, it so happened, that a neighbor's tow-headed urchin was in the back end of their lot "shooting" chickens with the spotlight from an 8″ x 10″ glass. It suddenly occurred to this boy to "shoot" me, and if there is anything in the transference of thought, I aimed at him. My flash struck his glass, his head glowing like an arc lamp. His ray struck my mirror, and it flew from my hand as I received a shock which I can only liken to the effect of the discharge of a Leyden jar, which once I took thru my body and occasioned my classmates a hearty laugh. That was many years ago, when they made electricity with a glass wheel, turned with a crank and by a *crank* and nothing was known of the art as we know it today.

To return to the battery of glasses. The boy received no shock. His mirror was incased in a wood frame. There was no frame on the glass I held and my fingers were in contact with the metal foil on the back. I stood on a wooden porch six feet above the ground and he stood on the ground, we were distant about 100 feet.

This theory has, so far, satisfied my mind, and I have given it some thought: The effect was due to an electric charge, generated by the rays of light traveling in opposite directions. The boy's focused rays impinged upon mine. Friction and velocity of the rays of matter (and sunlight is matter) produced the electricity which tried to convert my body into a condenser of considerable capacity.

In my general practice I have found that heat is a conductor.

While this letter may be of little interest or importance, it may encourage some experimenter to solve the problem of generating current from sunlight.

FULTON GARDNER.

Chicago, Ill.

[*A very interesting phenomenon. We tried to duplicate the experiment but with negative results. Perhaps some of our readers may have better luck. In that case we hope to hear from them. Mr. Gardner's theory is plausible enough to explain the phenomenon, which, we admit, was new to us.—Editor.*]

A COLLEGE STUDENT'S RECOMMENDATION.

Editor Electrical Experimenter:

Several years ago, while attending High School, I purchased two copies of your magazine. Ever since then I have bought every issue of your invaluable publication and have read and actually studied them. I always keep them handy for reference, and have almost every issue, from that of June, 1915, to the present issue. The few that I lack, I loaned to several friends upon request, and evidently they liked them so much, they forgot to return them.

I have found your magazine invaluable to me in my studies, clearing many problems, both in physics, chemistry, and the many courses in wood and metal working during the four years which I attended Stuyvesant High School. I may add, that I consider the ELECTRICAL EXPERIMENTER very instrumental in securing for me *a rating of* 100% *in a Regents' Physics Examination.*

The principal thing that I like about your magazine is its clearness. In fact, I firmly believe that it ought to be used as outside reading matter in conjunction with the regular text-books in technical schools. It is all very well to study the standard text-books of science, but still, one must keep abreast of the times, and to all such, I earnestly recommend your publication.

The only criticism I have to make (I admit that adverse criticisms are hard to find) is that Mr. Gernsback indulges in too much fantastical theories. The readers would very much appreciate other opinions of leading men in science. The only other fault I have to find, is that when I buy a copy of the magazine, I cannot stop until I have finished it, and then I am sorry that there is not more, which leaves me for another month with plenty of food for thought.

By the way, I forgot to tell you how I was prompted to write this letter. In the current issue (January, 1918), I read with keen satisfaction an explanation of a trench-telegraph system operated upon the induction plan. I am at present a student in the College of the City of New York. At the College, there are usually several companies of Signal Corps officers stationed there, who use the College Radio Station for instruction purposes. One day, I watched with keen interest several of the officers operate a mysterious instrument in the field. To this instrument were attached two wires, running along the ground for a short distance. Several hundred feet away was a duplicate of this apparatus, with the wires stretched parallel to the first. Both men wore wireless receivers attached to headbands. As the men were deeply engrost in their work, I refrained from asking questions.

Since then I have tried to satisfy my curiosity concerning the instruments they used, and received a grateful surprise when I read your exceptionally clear explanation in the current issue of the ELECTRICAL EXPERIMENTER.

But there is one thing lacking. Try as hard as I can, there are a great many things in science that I cannot obtain a satisfactory explanation for, such as the induction motor, induction furnace, Audion bulbs, etc. If I obtain an explanation, it is so surrounded with high sounding technical terms that I obtain a very faint, hazy idea of "how the thing works." I would suggest that you start such a department in your publication, using as little technical language as possible. One more thing before I forget, why not introduce more stories, anecdotes, jokes, etc., based on "scientific plots?" I am sure that your magazine will become more interesting and popular.

I hope that the ELECTRICAL EXPERIMENTER will continue in its good and useful work.

J. H. GANCOVITZ.

New York City.

[*We like letters of this sort, they are the sort that make for a better magazine. We will shortly have articles on the induction motor, as well as induction furnace. As for the Audion we publisht several exceptional articles as for instance in our August,* 1916, *as well as in our May,* 1917, *issues.—Editor.*]

MR. RUSK'S ARTICLES.

Editor Electrical Experimenter:

You have asked so often for the ideas of your readers concerning the contents of your magazine that I feel obligated to write you.

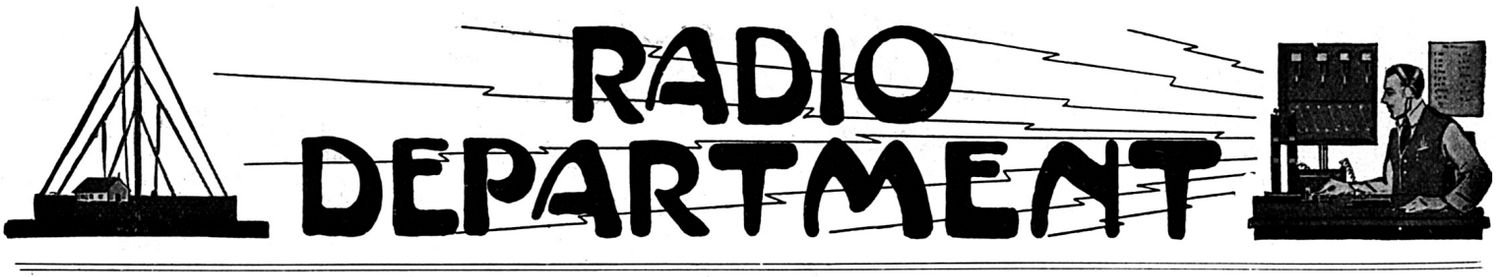
To begin, I wish to congratulate you on your loyalty to the cause of "Semi-Technical Electricity." Other publishers have drifted toward the so-called popular side of science. That field, I suppose, *does* interest more people than the "Semi-Technical," but I am sure you will find at all times an enthusiastic support from those who regard Electricity with more of the serious interest than of mere curiosity, if you continue in your present course.

There is next to nothing I can say in criticism of what you now publish. I can only offer a few suggestions as to what you might give us from time to time in the future. These must necessarily be somewhat specific, for, as I have just said, your general course is above criticism.

I like to read the ideas of America's greatest scientists and engineers who live in the *present* and the *future;* articles written by them personally, unalloyed by the views taken by some presumptious editor or reporter, who knows pretty nearly nothing about the subject. I am very fond of the articles which give the imagination exercise; which transcend what is commonplace; which are likely to form the stimulus for more deep and concentrated thought on the part of us "Bugs." Who knows but one or several of us may step later into the rôle of those men who wrote the articles for our benefit and whom we will succeed in their great work? Continue the picture supplements, please, as long as there are any celebrities to take pictures of. I am anxious to see another series of articles on "Modern Physics," now that Mr. Rusk's has been concluded. Personally, I should be interested greatly in much closer details than he has given us as well as facts and laws of the quantitative side of such subjects as photo-electricity, wave motions, radioactivity, electronic phenomena, etc. In a copy of *Motor Age,* I read an article, a sentence or two of which was devoted to a new form of gas battery, in practical use, so it seems, on German motor trucks employing platinum powder as a catalyzing agent and hydrogen and oxygen as its active elements. Can you publish further details about it? RAYMOND C. FISHER.

Tacoma, Wash.

[*We are pleased to state that with this issue Mr. Rusk is back once more. We had many similar requests to the one above. Sorry, but we could find out nothing about the alleged new German gas battery. Many new German devices must necessarily remain unknown till after the war.—Editor.*]



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

Intensive Training for the Signal Corps

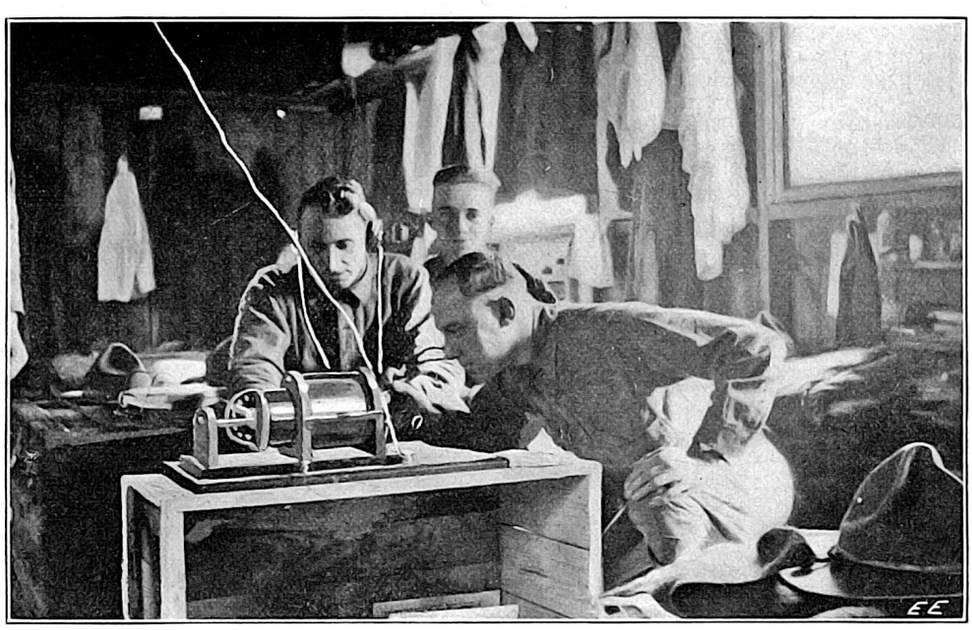
By A. C. LIETZ

THE men selected for commissions in the signal corps must, in the first place, possess some special qualification and be experts in some particular line such as telegraph, telephone, aeroplane, gas engine, balloons, radio telegraphy, photography, or be graduates in some allied technical branch. It remains, therefore, to give them a working knowledge of those branches with which they are not already familiar and to teach them those things not generally taught in the schools, namely: military maneuvers, visual signaling, military customs and regulations, court-martial procedure and the application of their technical knowledge to the science of warfare.

Before the entrance of this country into the war there were but two ways to secure a commission in the corps. One of these was by enlisting in the corps and passing an examination for a first lieutenancy. This was next to impossible as will be seen later, altho it has been done. The usual way was to take a special course at the Fort Leavenworth School after having been commissioned as second lieutenant in the line, that is, infantry, cavalry or artillery. This took about five years, including the four years at West Point. From this it will be seen that it is necessary to crowd five years' hard work into approximately three months, utilizing seventeen hours out of twenty-four.

First and foremost it is necessary to give the newly commissioned reserve officer a soldierly bearing. To this end he is given physical exercises to develop the muscles of his body uniformly, remove any superfluous flesh and increase his lung capacity. This is supplemented by infantry drill. He is taught not only to execute the movements properly himself but is given frequent opportunities to command units of various sizes, these being composed of officers undergoing the same course and who may then be termed the awkward squad and he must consider them as such. He must consider that he is in regular command of that unit and that it is composed entirely of raw recruits, explaining each movement before giving the command of execution, all under the watchful eye of the instructor. In this way he puts into practise what he has learned from studying the drill manual.

Several hours each day are devoted to conferences to discuss the lessons assigned and studied the night before. This covers "the soldier's bible," Army Regulations, also Signal Corps Drill Regulations, Field Service Regulations, and Manual of Court Martial. A part of the period assigned is devoted to a discussion and explanation of the subject and a part to answering questions of the student officers. These discussions form a very important part of the course, as they bring up many things not written in books. The naval and military service has a code of unwritten laws known as "customs and usages of the service." Some of these customs are as old as military history itself, and, are as interesting. They cover the personal conduct of the officer and his social conduct towards his fellow officers and towards the enlisted men. The students are taught what the older and experienced officers have learned from a study of the enlisted man.



Signal Corps Reserve Officers in Training, Listening to "Arlington" on an Experimental Radio Receiving Set, "Somewhere in the United States."

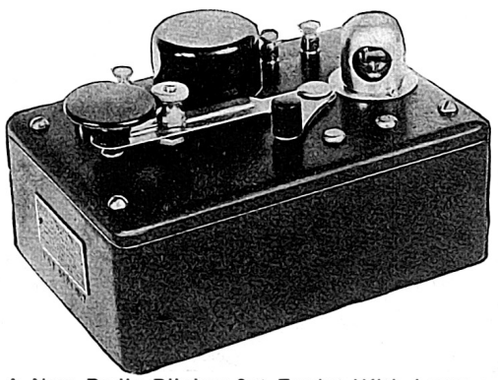
In order that he may secure the most efficient service from his men and equipment he must learn the operation, care and maintenance of the various instruments and means used for communication and also their limitations. It is not necessary that he be an expert in the use of all of them, but he should learn enough to be able to use them in emergencies and to be able to intelligently supervise the instruction of the men of his command by such of their number as may be expert. He should be able to use the semaphore and wig-wag flags, heliograph, acetylene lantern, telegraph wire.

(*Continued on page* 861)

A RADIO BLINKER SET FOR TEACHING CODE.

The cut herewith shows a new radio blinker signal set for teaching the code. This is self-contained in a cabinet, with sending key and a very sensitive, high pitched, high frequency buzzer.

The equipment comprises a buzzer and a lamp which may be operated separately by means of self-contained battery or outside current supply, in connection with two-



A New Radio Blinker Set Equipt With Lamp and Buzzer With Which the Student Should Learn the Code Quickly.

way switch and sending key. It is one of the most compact and most efficient devices available for purposes of practise and instruction by students in learning audible or visual signal codes.

It has not only been adopted by the Navy Department but is used in many branches of the Government service and by the best technical and radio schools for instructing aviators for both army and navy. It weighs about 1 lb. 6 oz. complete.

A HANDY RADIO CRYSTAL SET.

No more hunting around for that piece of crystal when the signals are not coming in strongly, no more soiled and broken crystals lying around in drawer's corner.

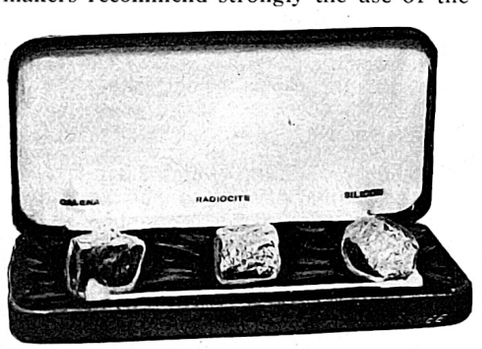
This new radio "De Luxe" crystal set not only obviates this, but the high class minerals furnished with the outfit will prove a boon for every operator.

The outfit consists of a water- and dust-proof, air-tight box of special construction, as shown in illustration herewith. The box can be carried easily in the pocket on account of its flat and neat shape.

It contains: One piece of Radiocite; one piece of Galena; one piece of Silicon, all tested.

Besides there is included one 18 Karat Gold Catwhisker and two phosphor bronze catwhiskers of different shapes.

The minerals should be handled only with pincers, never with bare fingers. The makers recommend strongly the use of the



At Last A Vest Pocket Radio Mineral Set. Contains Tested Rediocite, Galena and Silicon Crystals, Also Gold and Phosphor Bronze "Cat-Whiskers."

Gold Catwhisker with the Radiocite crystal. It is especially invaluable on board ships, as the gold cannot rust and no oxidation can set in between the catwhisker and the mineral.

CORRECTION!!

Editor of THE ELECTRICAL EXPERIMENTER:

Dear Sir:—Will you kindly publish this statement that the "graphic sign" (aA, Bbbb, etc.) referred to in leading up to my remarks on code-learning, in a recent issue of the EXPERIMENTER, *as one of the systems already in use, was invented and copyrighted, as I am advised, by Mr. F. S. Winger, of the Winger Electric & Mfg. Co., Chicago, Ill.*

Had I known who the inventor of the system was, I should have been only too glad to give him credit for it in my article, as I consider it by far the best method now in use for representing the characters of the telegraphic code.

THOMAS REED.

NEW WIRELESS COURSE IS STARTED AT CORNELL.

A special course in wireless work, designed to prepare men for service in the signal corps of the U. S. Army, has been instituted in the electrical engineering department at Cornell this term. The course is being given at the request of the government in order to fill some of the urgent needs of this arm of the service. It is offered to second term seniors only of whom about 17 have registered to date. Only students here will be enrolled so far as present plans go. The government has sent some special apparatus for the work which will be in charge of the regular staff of the department.

RADIO WRITERS — ATTENTION ! ! !

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army truck sets"; "improved ways of receiving undamped wave signals," also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

RADIO COURSE OPENED AT SYRACUSE UNIVERSITY.

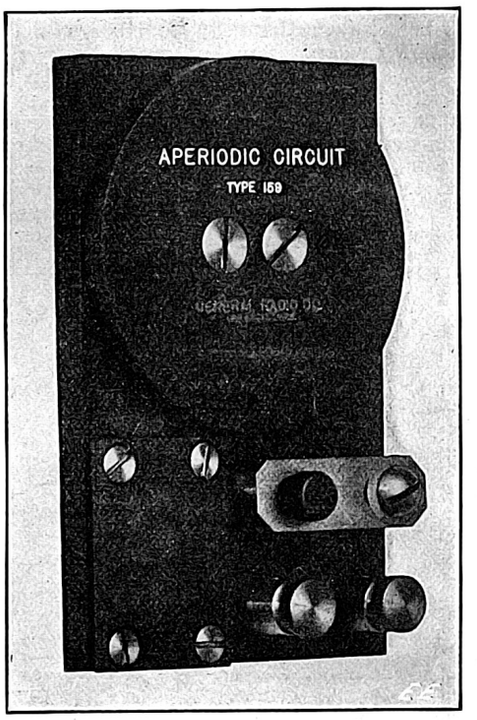
Announcement was made recently that Syracuse University, Syracuse, N. Y., has opened its first Government course of instruction to fit graduates from the College of Applied Science for radio service in the Signal Corps.

The teaching of this course of instruction will be conducted with the greatest of secrecy, Dean William P. Graham announces. Every student entering for the course, is required to take an oath that he will not reveal any of the instructions given him.

NEW PHANTOM ANTENNA AND APERIODIC CIRCUIT.

When radio engineers wish to test out a radio transmitting set, it is not always permissible or advisable to connect it up to a regular aerial. Hence this has resulted in the development of a localized antenna; i. e., a form of *lumped* capacity and inductance of the correct oscillating proportions, and so designed as to permit of passing thru or into it the same amount of energy in watts as would be sent into the actual antenna under working conditions. It's the same as hooking up a water-rheostat to a dynamo under a load test.

This phantom antenna comprises a mica condenser of .0004 M.F., capacity connected in series with a resistance of 4 ohms. It approximately duplicates the average *trailing wire* aeroplane antenna, and has a carrying capacity of 1.5 amperes, as indicated by a hot-wire ammeter. It will stand nor-



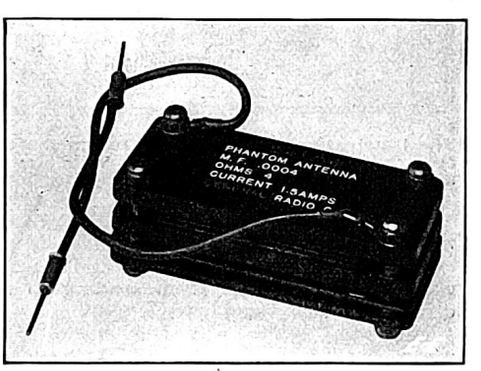
A New Radio Measuring Instrument. The "Aperiodic Circuit" Can be Used to Great Advantage in Determining the Point of Resonance in Damped Oscillating Systems.

mally a breakdown potential of 7,000 to 8,000 volts, and is very useful for tuning and testing aeroplane or other radio transmitters on the ground.

Aperiodic Circuit:

This instrument comprises a small inductance and large capacity in series with a crystal detector, with binding posts provided for connecting a set of head telephones. It is extremely useful as a tone tester for observing the quality of tone of a transmitter, but its greatest utility is found in its use in determining the point of resonance in oscillating circuits which are being excited by a damped wave.

For example: In measuring the natural period of an antenna the aperiodic circuit may be coupled loosely to the grounded antenna, a buzzer-excited wave-meter being also coupled to the antenna at a point slightly removed from the aperiodic circuit. When the wave-meter is then varied a loud response will be heard in the aperi-



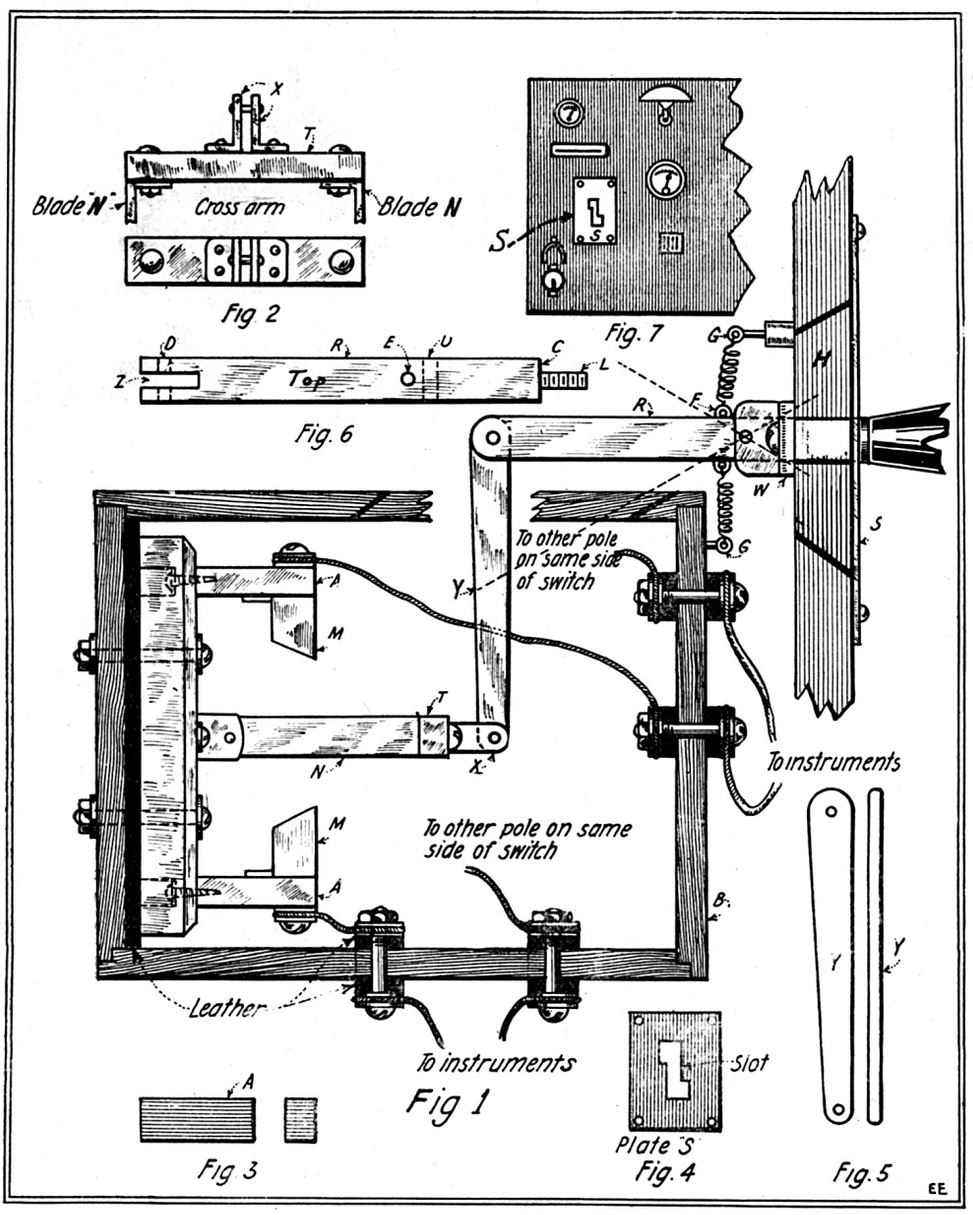
A "Phantom Antenna" Useful in Testing Aeroplane Radio Transmitters Without "Flying" the Apparatus. It Saves Much Time in Any Such Testing.

odic circuit when the wave-meter is in resonance with the natural period of the antenna. This is by far the quickest way to get the natural period of an antenna.

An Oil Antenna Switch for High Powers

By M. M. Valentine, Engineer

The drawing herewith, together with the following description, will enable the reader to construct an oil switch from any S.P.S.T., S.P.D.T., D.P.S.T., or D.P.D.T. switch; for that reason no dimensions are given for the construction of this switch, altho the one from which the drawings are made was an E. I. Co. D.P.D.T. switch. This oil switch will carry a much heavier load than heretofore and it is much easier and quicker to manipulate. The last reason makes it extremely valuable for wireless stations when changing instruments from sending to receiving or vice versa.



The Illustration Shows a Well Designed Antenna Transfer Switch of the Oil Immersed Type. It Is Suitable for Panel or Other Style Radio Transmitting Sets and Possesses Several Desirable Features, Including Small Space Occupied, High Insulating Value and Small Corona Loss.

The box "B" in Fig. 1 is made from wood, the joints of which should be made as tight fitting as possible. It is more than likely that it will leak at first but the oil will soon swell the joints and prevent this.

Referring to the diagram, it will be noticed that the jaw posts "M" (previously attached on the base) are set on uprights "A" which are made of wood, shaped as in Fig. 3. They are screwed to the base in positions from where the jaw posts "M" were removed. "Y" is made from sheet brass or iron and constructed as in Fig. 5. It is fastened to the cross-bar "T," by means of hinge posts "X" which are also of brass and constructed as shown in Fig. 2, leaving about one-eighth inch play between uprights.

The lever arm (R) is made from brass or iron, patterned as in Fig. 6. The slot "Z" is cut to admit "Y" as shown in Fig. 1. The hole "U" is drilled about ⅔ the length of the arm from the hole "D." At "C" a thread is tapt to admit threaded rod "L," which is ⅛ or 3/32 inches in diameter, depending upon the type of handle used. The hole "E" is drilled and small screw-eyes soldered in as in Fig. 1. "R" is fastened to switch-board "H" by means of the hinge posts "W" which are constructed the same as hinge posts "X," Fig. 2. About ⅛ inch side play is left, the reason for this will soon be shown.

The binding posts are fastened to box as shown in Fig. 1. The black-shaded portions being oil-soaked leather washers. The switch base also has a piece of oil-soaked leather, which is one-half inch longer and one-half inch wider than the base. The two bolts used for fastening base to box are also provided with leather washers.

The plate "S" as shown in Fig. 4 is made from sheet brass and is cut as shown. The notches in the slot are used to hold the lever arm "R" in down or up position, which in turn throws switch blades from one side of switch to other side or vice versa. This is the reason for the play left in hinge posts "X" and "W" as previously mentioned.

The switch is now ready for assembling. The parts are put together, connections made and box filled with transformer oil about one-half inch above top jaw posts. The cover is then fastened on by means o a set of hinges. Two springs of equal tension are fastened to screw eyes "F" and "G." These springs hold the switch in neutral position when not caught by slots in switch plate "S," on front of switch-board. The entire switch is mounted on brackets which are fastened to back of switch board.

ETHERIC MEMORIES.

-.-./- -.-/-.-/.-/ Those were the days, you bet, four nice, stiff, resisting galvanized iron wires towering twenty full feet above the old back shed, the roof porous with leaks and twenty-four slates missing, of course used for insulators and all the fences in the neighborhood shy of wire.

Yes, don't you remember of calling all the neighborhood in to hear the local 50 KW station in full blast, and just as you are about to push out your chest the blamed outfit refused to work, of course you loomed up as the largest fake in the country right there and then. Yes, and all Grandma's needles disappearing and the front door bell refused to work because you took out the carbons for that supersensitive carbon detector. And wasn't it remarkable when one thinks about it, that every time you struck the table you could hear all kinds of signals and only wished that you knew the code for it must have been China, Germany, or Japan, it could have been old Teddy Roosevelt down in the jungles cornered by wild tigers calling for help. S.O.S. Same old stuff—and then, it could have been old Johnny Barleycorn calling C.Q.D.—Can't quit drinking, S.O.S. Same old souse.

Well, I struck the idea of connecting my sounder in series with the carbon detector and batteries, the result was really astonishing, honestly, it sounded like a real telegraph office in full blast, it worked scrumptuously. Yes, Sir, after months of nerve racking and a thoro course in swearing, don't you remember how easily you acquired the habit, why I could easily swear 2,000 times without repeating the same word, and that in a very few months, some of the words were really radio like, and I am sure they could only be interpreted by another oscillating fool.

Next on the market came Silicon, Ah! that silvery mineral, which I tried to melt for key contacts, the procedure was something like this: After burning about fourteen sacks of charcoal and melting the bottom out of five or six pots I gave it up as a hopeless case, but my troubles did not stop there, I had greatly depreciated the value of the kitchen outfit, in fact Mother had to cook in an old cracker box until Dad could get to town, not to mention the number of barrel staves he broke, using the place where I sit down for that purpose, before he left.

Then came the news of the famous loose coupler; even tho I did not succeed in making a good one I can inform you that my decrement was very low when I did

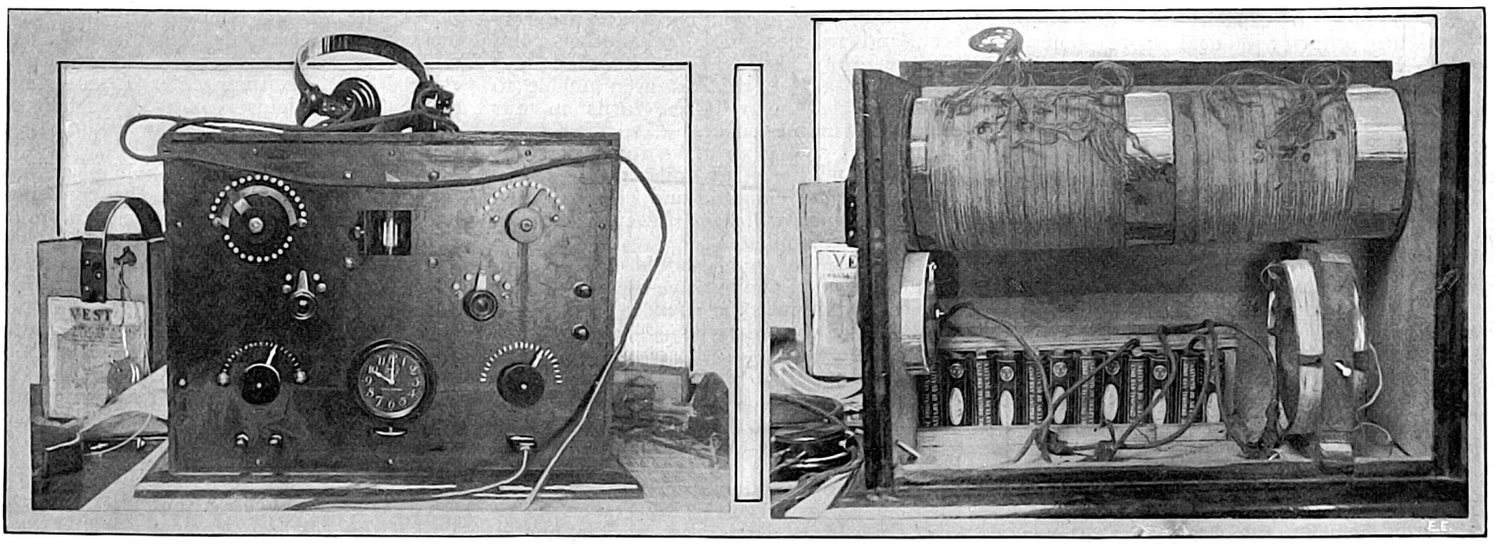
(*Continued on page* 858)

A Motor-Boat Radio Receptor

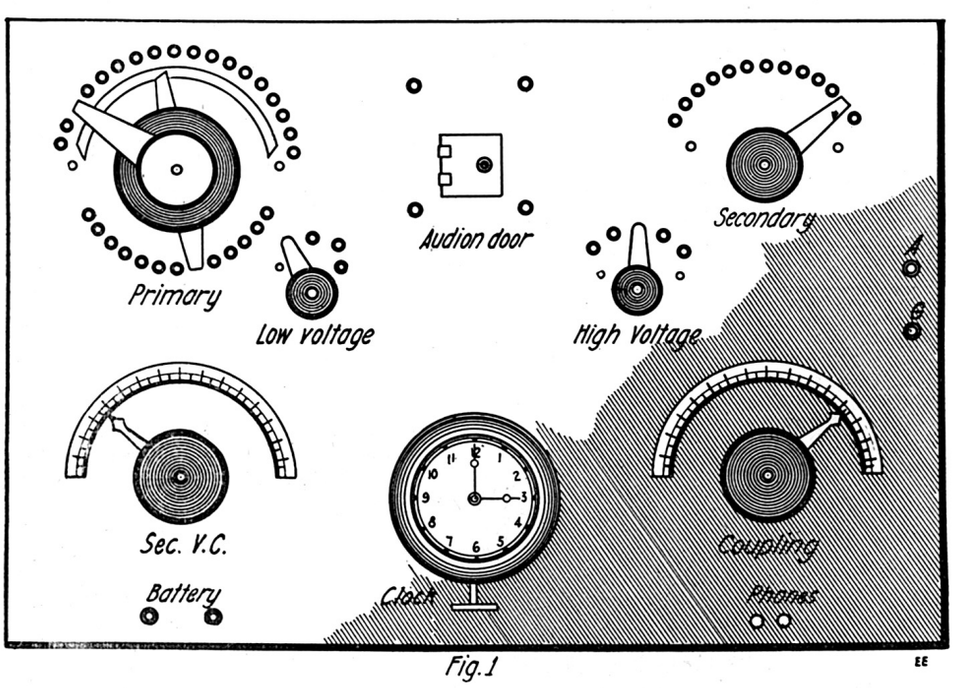
By F. MacMurphy

I HAVE here attempted to present a design of a Radio Receptor for motor-boat and yacht service. Ih ave aimed to produce a novel type of receiver, paying special attention to both mechanical and electrical efficiency.

The panel design is shown in Fig. 1. This panel, which is of Bakelite, is 15½ inches long by 11½ inches wide, with a thickness of 3/16 inch. Special attention is directed to the arrangement of the different adjustments on the panel. Beginning at the top we find the primary knob at the left, while the inductance control knob of the secondary is found at the right. At the center of the panel we have the Audion switch on the left, with the high voltage battery switch at the right. At the bottom of the panel we find the secondary condenser knob on the left and the coupling ment. The upper binding post A, at the coil arrangements at the right. Between the latter two adjustments I have placed a Waltham two-day clock. The telephone cords are fitted into a plug to make connection with the panel. The two binding posts at the bottom of the panel connect with the battery used to light the Audion filaments. By means of the door provided in the front panel, the Audion can be adjusted to the correct degree of incandescence. The dials are painted with phosphorescent radium paint. Details for the coil windings and condensers will be found in another article by the author which appeared in the February, 1918, issue of this journal, page 686, under the title "Detail Construction of a Damped and Undamped Wave Receptor."



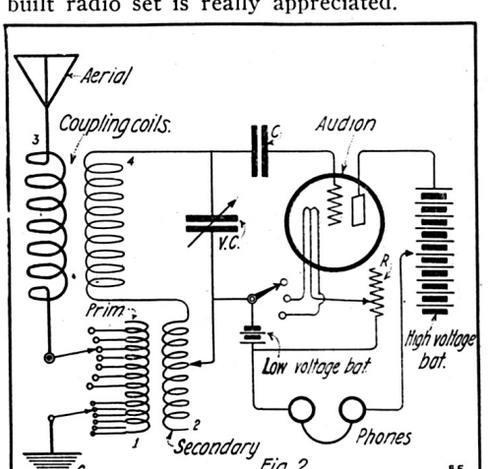
Front and Rear Views of Compact, Well Designed Radio Receiving Se t for Motor-boat, Scout and Sub-Chaser Service. Adaptable for Use With Damped and Undamped Signals.



General Layout of Radio Receiving Panel Set. Tubular Audion is Enclosed in Cabinet and Covered by a Small Door as Shown. A Special Coupling Transformer is Employed.

The various difficulties encountered in the proper installation and adaption to motor-boat and yacht "radio" have been overcome in this receptor.

Where space is at a premium and short compact aerials a necessity, the equipment must be of the best to give really good service. Not only as a convenience, but capable of rendering its true value in case of dire necessity, and thus it is that a well built radio set is really appreciated.



Hook-up for Radio Receiving Set for Motor-boat Service, Showing Tuning Transformer, Also "Coupling" Coils, Audion, et cetera.

This panel, which is of Bakelite, is 15½ inches long by 11½ inches wide, with a thickness of 3/16 inch. Special attention is directed to the arrangement of the different adjustments on the panel. Beginning at the top we find the primary knob at the left, while the inductance control knob of the secondary is found at the right. At the center of the panel we have the Audion switch on the left, with the high voltage battery switch at the right. At the bottom of the panel we find the secondary condenser knob on the left and the coupling ment. The upper binding post A, at the right of the panel, is to be connected to the antenna, while the lower post, G, connects with the ground lead.

The coils Nos. 1 and 2, as given in the wiring diagram of Fig. 2, are constant in coupling, the coupling variation being given thru the coils Nos. 3 and 4. The former are mounted as shown in the cut. This cut also gives the arrangement of the other coils as well as the high voltage batteries. Every part of the set is made as rigid as possible.

The battery rheostat is adjusted by means of a handle at the left side of the cabinet.

RADIO REACHES U. S. FROM NORWAY.

A new wireless station just erected at Stavanger, Norway, has succeeded in communicating easily with American stations during trial. Regular transatlantic service between Norway and the United States will be started soon.

The Design and Use of the Wave-Meter

PART 2

By Morton W. Sterns

IN the last installment we discust the underlying principles of wave-meter design and how the various ratios of inductance to capacity are determined.

This paper will deal more generally with inductances and capacities, and it is well to note that the same principles underlying receiver design also concern wave-meter design, and that, moreover, the sharp tuning values of inductance and capacity used in wave-meter design are more than welcome in radio receiver work.

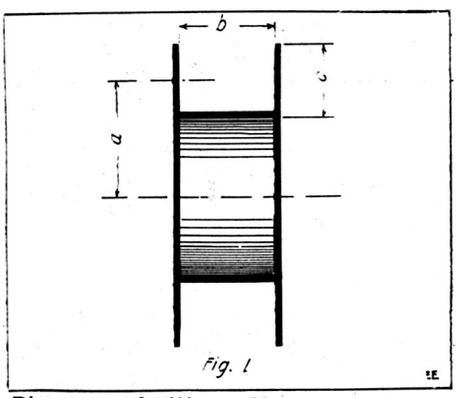


Diagram of Wave-Meter Inductance Form, Showing the Geometrical Dimensions Used in Computing the Inductance Value in Electrical Units.

To return to our particular design, we will calculate the size and number of turns per coil by means of Perry's formula, which is very easy to handle, and has been checked in any number of cases to be relied on to give values within 1 per cent. to 2 per cent., and in extreme cases to within 5 per cent. This formula is only of use in calculating the inductance of pancake coils and transmitter spirals and becomes inaccurate when b/c becomes large with respect to a L cms. =

$$\frac{4\pi\ n^2\ a^2}{0.23a + 0.44b + 0.39c} \text{ or } \frac{31.9n^2\ a^2}{0.23a + 0.44b + 0.39c} = (4)$$

Where:

L = inductance in centimeters.
n = number of turns.
a = mean radius.
b = axial length of coil (not wire).
c = radial depth.

If all dimensions are in centimeters the first formula is used, Fig. 1; but if all dimensions are in inches the factor 31.9 is introduced to care for the change in unit.

By experiment it has been found that the most efficient coils, viz., the ones having the least losses, have a mean diameter of six inches. And since we have selected as our conductor 3x16xNo. 38 *"Litzendraht"* (stranded insulated cable) which has an outside diameter of 0.052-inch, occupying approximately the same space as No. 16 B. & S. solid wire, we have enough data to calculate our coils.

We will start with the largest coil and make all our coil forms of the same size.

Coil 4 will have 1,310,000 cms., and assuming "a" as 3 inches, "c" as 1 inch and "b" as .2 we have:

Substituting in equation (4)

$$1{,}310{,}000 = \frac{31.9(n)^2\ (3)^2}{.23(3) + .44(.2) + .39(1)}$$

$$31.9x9\ n^2 = 1{,}530{,}000.$$

$$n^2 = 5450.$$

$$n = 74 \text{ turns.}$$

Now, since the winding space is 1 inch deep and there are 74 turns, they will have to lay four wide. Therefore, the width, b, must equal 4x.05-inch, or .2-inch, so our assumptions as to winding space are correct, and we need not try another combination of "b" and "c," which would have been necessary if we had been unable to accommodate the required turns in our assumed winding space.

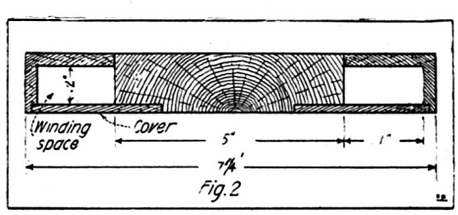
The next step is to make four forms of this size, and the other coils can be calculated as in the example and placed in the forms; as each will have fewer turns than the coil calculated.

Some form of plug should be fitted to the flexible cord of the wave-meter in order that it may fit into the sockets of any one of the four coils desired. The exact details of the design of the plug and socket connection is left to the builder's ingenuity.

The sketch (Fig. 2) shows a rather nice form of coil that will house all of our coils and will look very well if made of Bakelite.

A point to be remembered in designing wave-meter and receiver inductances is to keep the coil as narrow as possible, and if many turns are necessary to make the coil up on a form having several parallel slots, each of which is narrow.

We will now look into the various types of condensers in use. The most convenient form; the one most in use being the ordinary semi-circular plate type, familiar to all radio students. In order to make the plates remain in any position the movable plates are sometimes placed half on one side of the shaft and half on the other;



Proposed Design of Wave-Meter Exploring Coil, to Be Made of Mahogany or Other Hard Wood. The Coil Is Entirely Enclosed, as Shown.

thereby balancing the movable unit. Of course, these movable plates interleave with two sets of stationary plates set 180° off from each other. Naturally both sets of stationary plates are connected, and since both sets of movable plates are connected on the same shaft they are of one polarity. The following sketch (Fig. 3) shows roughly the above principle.

The Marconi Co. have what they call their "double" condenser, which has several advantages, namely, compactness, ruggedness and *double capacity variation per degree of scale.* This condenser, due to its connections, requires a box only one-half the depth of the ordinary type condenser box of the same capacity, and due to its rugged construction and the use of heavy castings it is extremely permanent in its calibration. A curve showing the relation of the capacity to the degrees on the scale of a condenser of this type between the limits of 10° and 170° on the scale is an extremely straight line variation.

Fig. 4 shows the Marconi "double" condenser diagramatically. Here A and B are the stationary plates, insulated from each other and forming the condenser terminals. A^1 and B^1 are the movable plates turning with shaft S, but insulated from it and each other. Plates A and A^1 are connected together and plates B and B^1 are connected together. Now, when the condenser is in the position shown with each set of movable plates interleaving its own set of stationary plates, it is evident that the capacity will be zero. However, if the shaft S is rotated 180°, so that plates A^1 interleave plates B, and plates B^1 interleave plates A, is it evident that we have maximum capacity.

In all wave-meter work where calibration must remain constant, the condenser must be made along certain lines to assure permanency. All bearings should be large and rugged and capable of taking up wear. Plates should be of large diameter and of at least 1/32-inch material to provide stiffness and fredom from temperature changes. Fairly large spacings and more plates is the preferable construction. Under no circumstances should insulating bushings be used, as they introduce hysteresis losses and also allow warping. The better construction makes use of the entire end pieces of insulation such as Bakelite.

There has lately been put on the market a new type of meter known as the *Kolster decremeter,* which incorporates several novel features, among which is the direct-reading scales for wave-length and decrement.

The meaning of *logarithmic decrement* was fully explained in the preceding article and with this in mind we will try to show how it is measured and how the Kolster Decremeter varies from other meters of its type. Let it be understood here that there are any number of wave-meters and decremeters on the market at present, and that they differ only in the respect that the Kolster Decremeter incorporates special features that allow direct reading decrement and wave-length scales to be attached. What these special features are will become evident during the course of the paper.

Bjerkness has shown that for two loosely coupled circuits the following relations exist:

$$\delta_1 + \delta_2 = \pi\ \frac{C_r - C}{C}\sqrt{\frac{I^2}{I_r^2 - I^2}} \quad \ldots\ldots\ldots (5)$$

Where

δ_1 = Decrement of primary circuit.
δ_2 = Decrement of secondary circuit.
C_r = capacity at resonance giving current I_r.
C = Capacity a slight degree off resonance giving a current I.

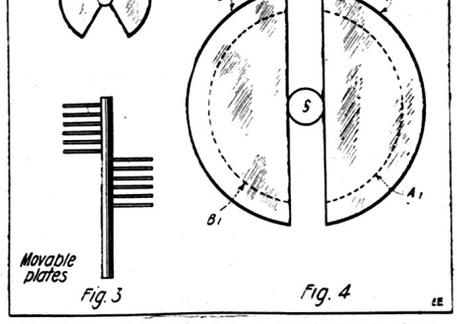


Fig. 3—A Balanced Type of Variable Condenser. Fig. 4—The Marconi "Double" Variable Condenser, in Which Two Sets of Fixt Plates and Two Sets of Rotary Plates Are Used, Resulting in Less Volume and Double Capacity Variation per Scale Degree.

The conditions under which this formula may be applied with sufficient accuracy are:

1. That $\delta_1 + \delta_2$ be small compared with 2π.
2. That $\frac{C_r - C}{C}$ be small as compared with unity.
3. That the degree of coupling between the two circuits be small.

Equation No. 5 immediately suggests a simple and generally used method of calibrating a decremeter. Suppose the primary consists of a circuit embodying some form of oscillating vacuum tube, such as the Pliotron, emmitting sinuosoidal waves of constant amplitude, or undamped waves; then it is evident that δ_1, the decrement of the primary circuit, is zero and any decrement measured is the *meter decrement.*

Let us assume that it is desired to measure the logarithmic decrement of the oscillations in the antenna circuit of a radio transmitter, as shown in Fig. 5.

A circuit containing inductance L, a calibrated condenser C and a sensitive low-resistance, hot-wire instrument H, is very loosely coupled to the antenna circuit A. Readings of the hot-wire instrument H, which are proportional to the square of the current flowing in the circuit, are taken for several values of capacity C on both sides of the resonant value C_r. Plotting these readings against capacity, a resonance curve as in Fig. 6 is obtained and from one of the following folmulæ the sum of the logarithmic decrements may be obtained:

$$(6)\quad \delta_1 + \delta_2 = \pi \frac{C_r - C_1}{C_1} \sqrt{\frac{I_1^2}{I_r^2 - I_1^2}}$$

$$(7)\quad \delta_1 + \delta_2 = \pi \frac{C_2 - C_r}{C_2} \sqrt{\frac{I_2^2}{I_r^2 - I_2^2}}$$

$$(8)\quad \delta_1 + \delta_2 = \pi \frac{C_2 - C_1}{C_2 + C_1} \sqrt{\frac{I^2}{I_r^2 - I^2}}$$

If the decrement δ_2 of the measuring circuit or decremeter has been previously found, the decrement δ_1, of the antenna circuit under test is at once obtained by subtracting the meter decrement from the measured value.

In practice it is found permissible to make the change in capacity from C_r to C_1, or from C_r to C_2, such that I^2 becomes $\frac{1}{2} I_r^2$, thus making the expression under the radical sign equal to unity.

In practice a handle about 18 inches in length is fastened to the movable plates of the variable condenser so as to be able to control the fine movements more accurately, as a small movement of the condenser in degrees makes a relatively large movement on the scale of the hot wire instrument in the vicinity of the resonance point. Below is tabulated a set of experimental data taken from the antenna circuit of a quenched spark transmitter and plotted in the graph shown in Fig. 6.

Wattmeter Reading or I^2	Wavemeter Capacities in Mf.
.008	0.00125
.011	0.00124
.016	0.00123
.022	0.00122
.028	0.00121
.035	0.00120
.038 resonance....	0.001195
.036	0.00119
.026	0.00118
.016	0.00117
.011	0.00116
.007	0.00115

Of course, the reader understands that the above data accurately combines two sets of data in one. The usual procedure is to plot the watt-meter readings against degrees on the scale, and then to look up the condenser calibration, which is furnished with every wave-meter, and which shows the capacities of the condenser for various scale readings in degrees.

From the plot in Fig. 6 it is seen that at resonance I_r^2 is 0.038, corresponding to 0.001195 mF.; I_1^2 equal to $\frac{1}{2} I_r^2$, corresponding to 0.001173mf. at 0.019 on the wattmeter scale. I_2^2 equal $\frac{1}{2} I_r^2$, or 0.019 watts at 0.001225mf.

Since I_1^2 or I_2^2 is equal to I_r^2 then the quantity under the radical sign becomes

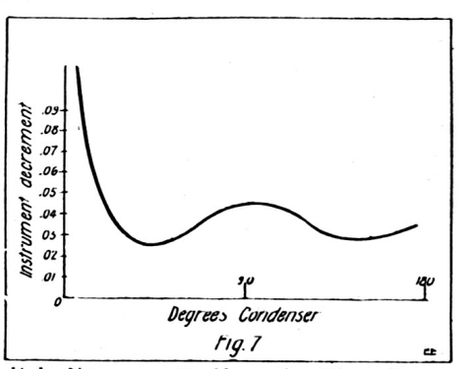


Fig. 7

It Is Necessary to Keep the Wave-Meter Decrement Low if We Wish to Measure Small Decrements. An Average Value of Decrement for Each Inductance Is Generally Used, as It Varies From Point to Point, as Illustrated Above.

$$\sqrt{\frac{I_1^2}{I_r^2 - I_1^2}} = \sqrt{\frac{.019}{.038 - .019}}$$ or equal to one; therefore, it may be omitted in our calculations.

From equation (6):

$$\delta_1 + \delta_2 = \pi \frac{C_r - C_1}{C_1} = 3.14 \times \frac{.001195 - .001173}{.001173} = .057$$

Similarly from equation (7)

$$\delta_1 + \delta_2 = \pi \frac{C_2 - C_r}{C_2} = 3.14 \times \frac{.001225 - .001195}{.001225} = .0769$$

Average, $\delta_1 + \delta_2 = .0669$.

The value of δ_2 is given with the decrementer and is equal to .016. Therefore .0669 — .016 = .0509, which is the logarithmic decrement δ_1 per complete oscillation.

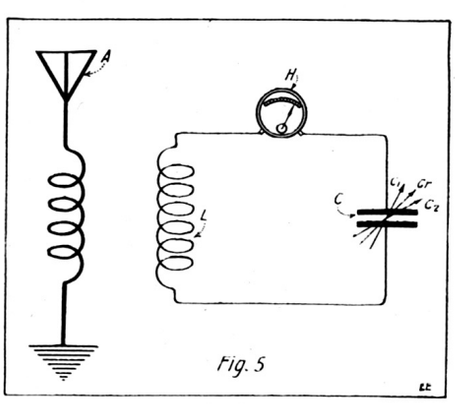


Fig. 5

Arrangement of Apparatus for Measuring the Logarithmic Decrement of a Radio Transmitter Aerial Circuit. A Hot-Wire Meter Is Connected in Series with the Wave-Meter Inductance and Variable Capacity. Readings Are Taken for Different Positions of the Variable Condenser.

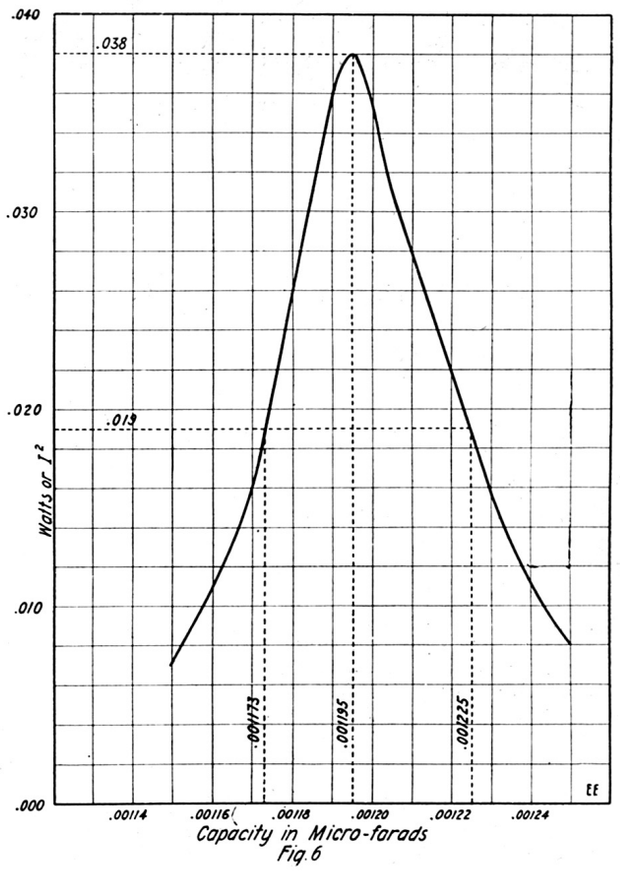


Fig. 6

The "Resonance Curve" Obtained from Tests on a Quenched Spark Radio Transmitter. It Is Plotted by Observing Successive Readings as Obtained by a Hot-Wire Ammeter and a Wave-Meter, Fig. 5. A Radio Expert Can Compute the Logarithmic Decrement from Such a "Curve," and Besides, He Can Tell at a Glance Just How Efficiently Tuned a Certain Transmitter Is. This Is Explained in the Accompanying Test.

In order to show the value of the resonance curve let us look a little closer into what the curve actually represents. The breadth and height of the curve show graphically the sharpness of tuning and amplitude of the oscillations.

The addition of resistance into the circuit has the effect of broadening the curve and at the same time lowering the height of the *hump* or peak. If the coupling of the transmitter is too close, the curve will decrease in height, broaden out and show two distinct resonance humps, which, of course, indicates that the energy is not being emitted all on one wave-length. Therefore, by merely looking at a well-plotted resonance curve a well-grounded radio man can tell at a glance if the transmitter is working at maximum efficiency, and if not, he generally can determine the reason.

Now, it also becomes evident that it is necessary to keep the meter decrement low if we wish to measure small decrements, because the meter decrement is always incorporated in the value read. An average value of decrement for each coil is generally used, as δ_1 varies from point to point as shown in Fig. 7.

The necessity of a low resistance wattmeter and the use of *Litzendraht* wire on the inductances also become apparent.

Now, the above readings necessary to measure decrement seem fairly easy to take, but without laboratory appliances at hand it is not as simple as it seems. So in order to make it easy for the radio inspectors of the Bureau of Navigation to make these measurements on shipboard Mr. Frederick A. Kolster designed his *direct-reading decremeter,* which we shall study in the next installment of this series.

(To be continued)

THE CONSTRUCTOR

A Synchronous Motor Made From An Iron Pulley

By Raymond V. Wilson

THE motor here described will run on single phase alternating current of 60 cycles. The iron parts for the motor are secured from an ordinary six-spoke cast iron pulley wheel of about 3 inches diameter. The wheel is removed from its bearings and the spokes sawed off with a hack saw at about the white marks as shown. The rim is used for the field or *stator,* and the inner part is used for the armature or *rotor.*

The space between the projecting pole-pieces on the stator is wound with wire. The direction of winding is reversed on the adjacent sections so that when a current flows thru the wire, the projecting poles will be alternately North and South. Before winding the stator, it should be given two or three coats of strong shellac solution, for insulating purposes, allowing each coat to dry hard before applying the next coat. This drying may be hastened by placing it in a warm but well ventilated place.

It is not necessary to wind the rotor poles for any of the experiments here mentioned, as the rotor will run synchronously without any winding, text books to the contrary notwithstanding. One is shown wound and equipt with slip rings, however, and it can be fed with a direct current from a battery to slightly increase the power of the motor. The windings of the rotor poles are alternated in direction so as to produce poles of alternate polarity the same as the stator.

The rotor is fitted with a shaft and mounted on bearings as shown. If the spokes have not been sawed off accurately so as to be of equal length, they must be filed or ground down so that the rotor will turn without scraping the poles of the stator. The shaft of the rotor should protrude somewhat thru the bearings as the motor is not self-starting and must be started by twirling the end of the shaft between the fingers after the current is applied. One does not always succeed the first time, as the rotor must be spun until it is near synchronous speed before the current will take hold and continue the rotation. Two or three volts alternating current applied to the stator winding from a toy step-down transformer will run this motor very quietly and smoothly and without overheating, but the bearings must be smooth, well made and well oiled.

The wire used on this particular motor is No. 21 B. & S. double cotton covered, but other sizes will answer as well providing that the transformer has other voltages which will run but not overheat the motor.

The speed (S) or number of revolutions per second of any synchronous motor may be found by dividing the frequency of the applied current (F) by the number of *pairs* of poles (N). This motor, having three *pairs* of poles and being fed by alternating current of 60 cycles, will revolve at a speed of 20 revolutions per second. Also

$$F = SN;\ S = \frac{F}{N} \text{ and } N = \frac{F}{S}.$$

Apply the low voltage alternating current to the stator winding and give the shaft a twist. If it stops, try it again or try giving it a twist and then apply the current quickly. After a few trials it should continue running by itself if the machine has been properly made.

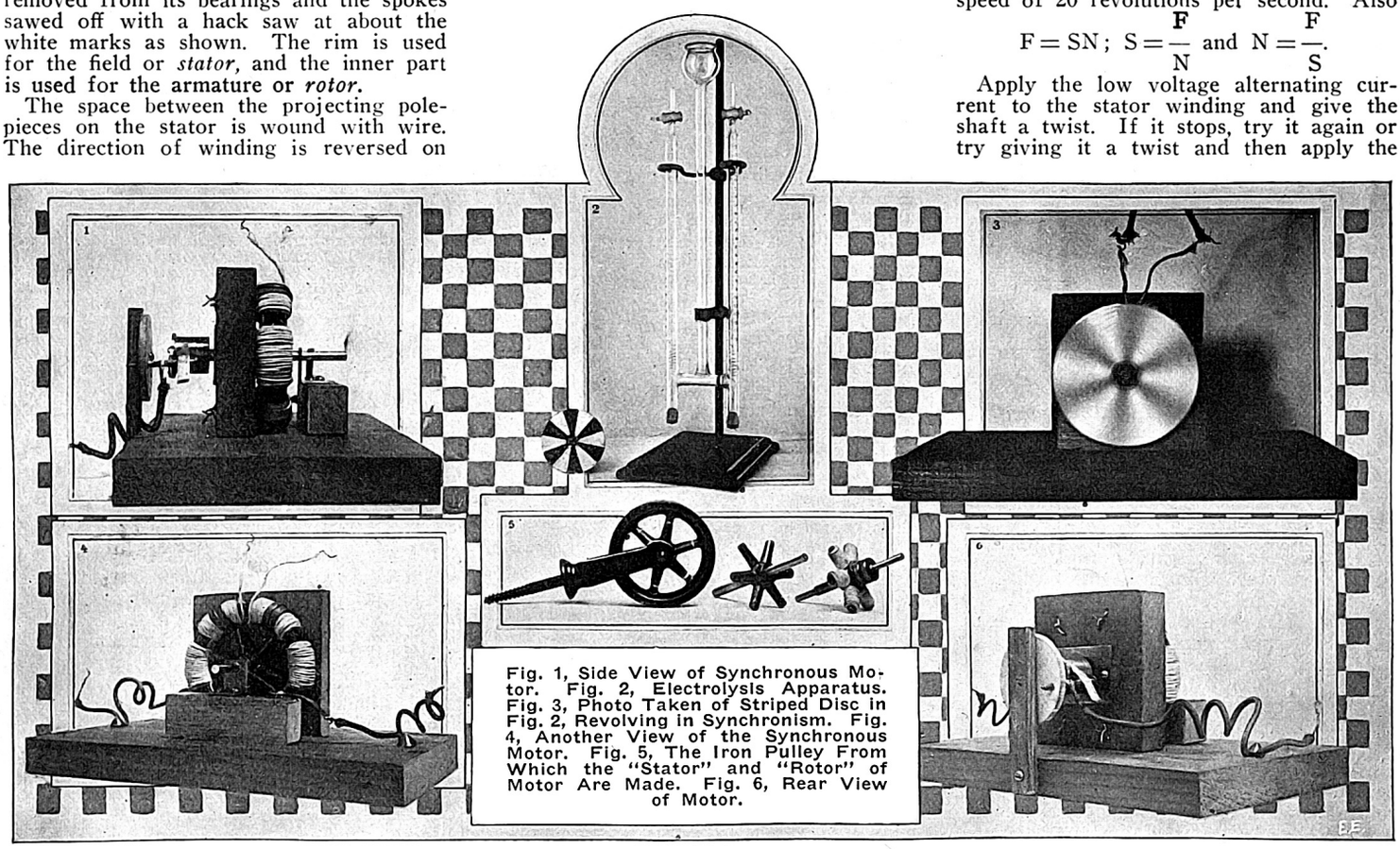


Fig. 1, Side View of Synchronous Motor. Fig. 2, Electrolysis Apparatus. Fig. 3, Photo Taken of Striped Disc in Fig. 2, Revolving in Synchronism. Fig. 4, Another View of the Synchronous Motor. Fig. 5, The Iron Pulley From Which the "Stator" and "Rotor" of Motor Are Made. Fig. 6, Rear View of Motor.

Alternating current flows first in one direction in the wire and then in the opposite direction, dying out to zero or no current between each pulsation or flow of current. See Fig. 1.

Alternating current of 60 cycles means that there are 120 of these pulsations every second.

Now to show that the motor is running *synchronously:* Take a cane or small stick and wave it rapidly back and forth in a darkened room illuminated by a single 10 watt (or even a 25 watt) incandescent lamp fed by alternating current. The cane or stick will appear like the blades on a fan. The filament of the lamp is heated red hot by these pulsations and the lamp gives the appearance of a continual glow of light, flickering not being noticed by the eye, as

the current pulsations are far too rapid. It is a similar effect to that of the moving pictures where a succession of pictures are thrown on a screen. They come so rapidly

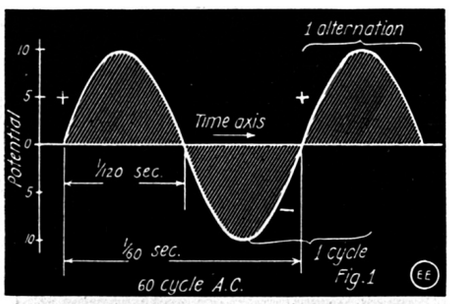


Diagram Showing How an Alternating Current Cycle Is Composed of Two "Alternations"—One a Positive Loop and the Other a Negative Loop.

that, with a good machine, the eye is not able to detect any flickering, altho *only sixteen* different pictures are shown per second when the machine is being run normally.

The filament of the ten watt lamp is very thin and fine and has a chance to cool off between pulsations of current, and 120 *times per second you are in the dark,* when the current is at zero and not flowing in the lamp. This is what causes the fan blade effect of the waving stick, as you do not see the stick at all during the dark periods.

A circular disc is cut out of a piece of card-board and marked into twelve equal segments, and these are alternately painted black and white as shown. This is affixt to the end of the rotor shaft with a bit of sealing wax. Now if the disc is illuminated only by a ten watt lamp, fed by 60 cycle alternating current, it will receive 120 flashes of light per second. If the motor is running and in *synchronism* (i. e., 20 revolutions per second), it is evident that the disc will be illuminated by six flashes of light during one revolution of the motor, and we will get six views of the disc every revolution. This is exactly what happens and in consequence the disc with its six black spokes *appears to be standing still,* altho revolving at the rate of 20 revolutions per second.

A photograph of several seconds exposure is shown, taken of the motor and disc while running in synchronism. The photo was taken by the light of a ten watt lamp, fed by the same alternating current of 60 cycles. It shows distinctly the six black sectors of the disc as if standing still. The edges of the sectors are not sharp for the simple reason that the current and consequent light pulsations are not abrupt, but undulating like waves on the ocean. (See Fig. 3.)

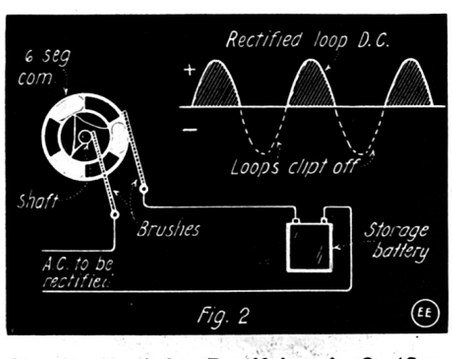
A similar effect is sometimes seen in moving pictures of a wagon which is moving but the wheels seem to be standing still. In this case it just happened that the wheel of the wagon *was turning in synchronism with the moving picture machine.* Each spoke of the wheel moving into the same relative position as the one before it as the pictures are taken.

Text-books state that the phenomenon of "hunting" is one of the defects of synchronous motors when used with a commutator for rectifying alternating current, and this motor is not entirely exempt. It may sometimes be noticed that the revolving disc illuminated by the lamp seems to waver or swing slowly forward and back., This is the phenomenon of "hunting" and is caused by the poles of the rotor sometimes revolving just a little beyond their corresponding poles on the stator. In trying to get back in their correct position in relation to the current pulsations, they swing back a little too far and slightly lag behind their correct position. This often occurs especially just after starting the motor, but usually it soon dies out and the spokes on the disc gradually appear to be standing perfectly still. In large machines when rectifying heavy currents this would cause trouble with the rectifying commutator, but with small currents it may be neglected.

As a *synchronous rotary spark gap* is most efficient for wireless work when using a closed core high voltage transformer, this motor can be used for that purpose. A wheel with six points (similar to the rotor of the motor) should be mounted on the shaft but thoroly insulated from it. The two stationary spark points must be placed at a certain position, to be determined by experiment, in order to get the most efficient spark thru the wheel.

If the motor is to be used as a *rectifier,* it must be supplied with a six segment commutator and mounted on the shaft as shown. This commutator had best be purchased or taken from a small toy motor.

Three alternate segments are connected together and in turn connected to the shaft of the motor. The other three segments are left dead. This arrangement will rectify *only one-half* of the alternate current waves. One brush bears on the commutator and the other brush bears on the opposite end of the motor shaft as shown. It is to these brushes that the alternating current to be rectified is applied, together with a storage cell or other apparatus connected up in series. See Fig. 2.



Circuits Used for Rectifying A. C. (One Set of Alternations) With 6 Segment Commutator Fitted to Synchronous Motor Here Described.

The commutator brush is made adjustable both as regards its tension and its position on the commutator. The brush should be placed at a point on the commutator where there is little or no sparking when it is running. There will be found six such points; three of them rectifying in one direction and the alternate three will rectify in the opposite direction. These points represent the *zero* when the current pulsations are reversing direction.

It is quite essential that the brush be placed exactly at the zero point on the commutator, as otherwise the current picked off will not be purely rectified but will have some flowing in the opposite direction, which would be fatal if it were being used for charging an expensive storage battery, as the battery would be ruined. In fact, this motor rectifier as described can be recommended only for experimental purposes, as sometimes the motor will stop for no apparent reason, and if a "live" segment of commutator happens to come to rest under the brush, pure alternating current will flow thru it. Experiments in charging a storage cell are best made with one constructed of two small lead plates dipping into a glass filled with electrolyte. If alternating current is past thru it by mistake it will only cause a white deposit to form on the plates (called sulfating) which in this case can easily be scraped off or it will sometimes fall off by itself.

In fact, such a cell is of assistance in finding the correct place for the brush on the commutator. If in the wrong place the plates will sulfate, while if in the correct place one plate will turn a chocolate color and the other will retain its original lead color, and the cell will be "charging."

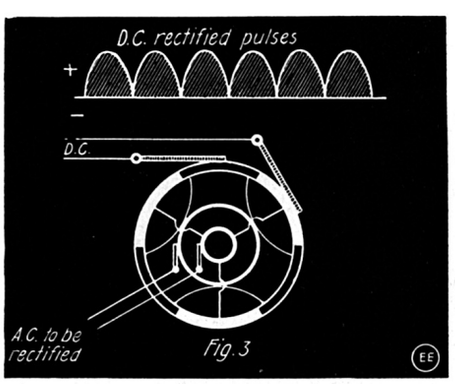
A small compass galvanometer is convenient for determining the direction of flow of the rectified current, as the motor will not necessarily rectify in the same direction after each starting, altho the position of the brush may be unchanged.

Such a galvanometer may be constructed from an ordinary compass by wrapping a few turns of insulated wire around it and connecting it in series with the current to be rectified. The compass is placed so that the turns of wire are parallel to the needle. If a direct current is past thru the wire in one direction, it will cause the needle to deflect to the right, and if the current passes thru it in the other direction the needle will deflect to the left. The needle is not quick enough, however, to follow the changing directions of a 60 cycle alternating current and it often demagnetizes the needle, as will also too strong a direct current, should there be too many turns of wire around the compass. The needle may easily be re-magnetized by passing the poles of a horseshoe magnet over the needle. If then the South end points to the North, it has been magnetized in the wrong direction and the opposite poles of the magnet must be past over the needle.

A compass galvanometer will not show whether or not a pure rectified current is flowing thru the circuit. The glass *Electrolysis Apparatus* shown in the photo Fig. 2, will do this, however. Advantage is taken of the fact that a current of electricity will decompose acidulated water into hydrogen and oxygen. With direct current, *oxygen* will be given off from one electrode and *hydrogen* from the other, in the proportion of one volume of oxygen to two volumes of hydrogen (H_2O). These gases rise in their respective graduated tubes and their volume can be read off directly. With alternating current the volume of the gases in the tubes will be equal and will consist of mixed oxygen and hydrogen. If the rectified alternating current is past thru the apparatus and the gases given off are not in the proportion of 1 to 2, it may safely be assumed that it is not a pure rectified current. Evidently the brush is not in its correct place on the commutator, or the rotor may be "hunting" excessively.

An electrolysis apparatus may be constructed from a tin pan. Two pieces of

(*Continued on page* 866)



Showing How It is Possible to Rectify Both Pulses of A. C. With Two Slip Rings Fitted to Six Segment Commutator on Synchronous Motor Described.

Electro-Static Experiments

By Frederick von Lichtenow

PART II (Conclusion)

SEVERAL years ago I happened upon the instructive and interesting little work entitled, "Simple Experiments in Static Electricity," by Percival G. Bull. Experiment No. 9, Chapter IV, of this book, dealing with spectacular condenser discharges, imprest me very much; in fact, to the extent that I couldn't help but give it the due tryout. The "bronze" or "metal" paper referred to and needed in the experiment seems, as I faintly remember, to be an uncertain article on the local market. There is something entirely wrong with it. Either the demand for it is so brisk that stocks are early exhausted, or there is no call for it at all, and, consequently, nobody bothers with it. I was for a time inclined to think the latter way, until finally, after a prolonged and fruitless search among the various stationery stores, I was shown at some small place what looked to be the remnant of a once glorious pile. Whether I purchased the real, honest-to-goodness "metal" paper or not has been an open question with me to this day, since it was not sold to me under that somewhat mysterious sounding name. At any rate, it works.

I mention this little incident only as an example of the handicaps, which at times confront the experimenter even in big cities, and which are only too frequently responsible for the fact that many otherwise highly instructive and fascinating experiments are left untried. Needless to say, I have had several real disappointments of this nature since, not only "close calls" like the above.

My aim in this article is to put down the results obtained with, and various spark effects noted on, three different grades of "bronze" or "metal" paper—the only number I was able to secure—which are not given in the aforementioned book. Following in the order of their relative resistance capacity they are "silver" paper, the "copper-bronze" paper and the "brass-bronze" paper, the latter being the poorest conductor of the three. They measure each, as cut by me, 19½ inches in length (the original width of the paper) by 8¼ inches wide, an ample size for the accommodation of even the largest Leyden jars ordinarily used.

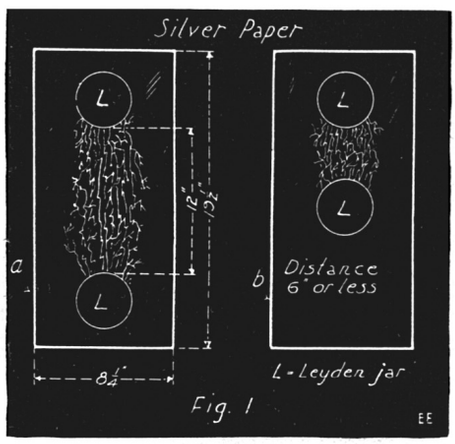
I employed in these experiments two very finely made static Leyden jars of one pint size each in connection with the always dependable little "Electro" Wimshurst static machine. According to the book in reference the jars are to be placed one at each end of the paper and connected with their inner coatings to the respective poles of the machine. I have placed them in various positions, these latter depending on the spark effect desired, as well as necessitated by the nature of the paper itself.

The following illustrations and short descriptions give the results of my tests (Fig. 1).

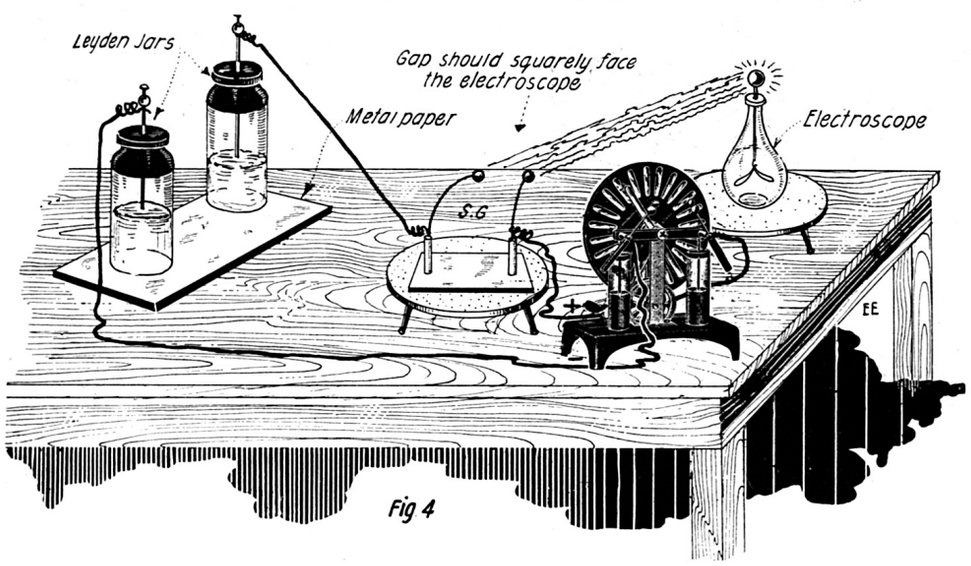
Characteristic of this paper is that the sparks always show a strong tendency toward branching out over its surface, whether the distance between the jars be a few inches or a foot, or even more. Their color is a beautiful bluish-white. With the jars separated by only a few inches, and up to six inches or so, the discharge manifests itself in thousands of bright little stars hanging together by shiny threads. These very striking effects are due to the relatively high conducting quality of the metal particles covering this paper.

The paper illustrated in Fig. 2, offering a somewhat higher resistance to the condenser discharge than the former, limits the distance between the jars to ¾ of a foot. At or near that distance the sparks are very pronounced and appear concentrated in the form of miniature lightning bolts of a clear white color. They hit around in curves and are accompanied by a loud report. If the jars are approached to within 4 inches or less, as indicated in "b," the sparks will dart in spray fashion across the intervening space, lighting up in a vivid emerald green. (Fig. 3.) As I have stated before, this paper is a poor conductor, and, consequently, permits only a separation of a few inches between the Leyden jars. Set at that distance, the spark effect is very similar to the one noticed on the "copper-bronze" paper, Fig. 2-b; however, it is not quite so distinct. The color shade of the sparks runs more into a dull yellowish green, not unlike that or oxidized brass.

The above spark-and-color effects are those as observed in an artificially (moderately) lighted room. The papers may be placed in triple or quadruple layers, thus insuring a better insulation for the Leyden jars, in addition to which an oilcloth covering on the table may be advisable. Care must be taken that the discharge balls of the machine are first to be separated *beyond* sparking distance while charging the jars, and not set "a few inches apart," as prescribed by the text book, which may be misunderstood, since the small Wimshurst machine I used in these tests delivers a three-inch spark alone, when in a healthy condition, not to speak of the many larger static machines with their correspondingly greater output. After thus charging the jars for a short while the electrodes are gradually and slowly approached toward each other, when upon reaching the stress limit the resulting spark will be accompanied by the condenser discharge across the paper.



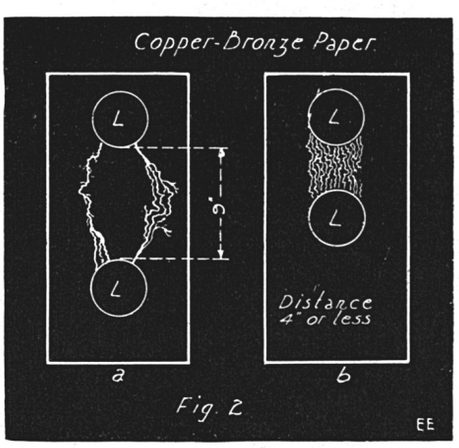
Spectacular Condenser Discharges Can Be Arranged With Metalized Paper, a Pair of Leyden Jars and a Small 3" Static Machine. This is a "Silver Paper" Experiment.



A Novel and out-of-the-ordinary Static Experiment Which the Author Discovered. The Insulated Electroscope Responded to the Unipolar Oscillatory Waves Set Up by a Silent Discharge in the Spark Gap, Owing to Its Ball Being in Line With Those on the Spark Gap.

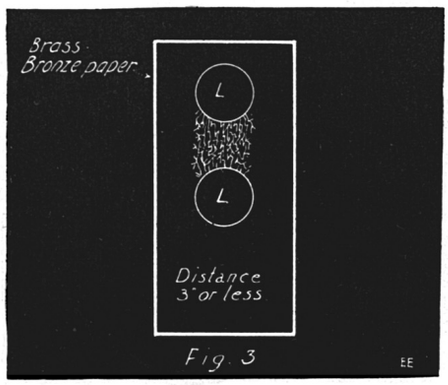
Following the above tests I was led to another experiment, terminating in the following discovery—if I may call it such—which I will give here for what it is worth:

In order to ascertain the conducting value of these metal papers as a circuit link, I had included a separate gap (spark gap) into the former set-up. With the conductors of the machine set wide apart I was testing the spark across this new gap under various



Different Forms of Discharge Effected Between Leyden Jars Set at Various Distances Apart on Copper-Bronze Paper.

adjustments, when, happening to glance around while turning the crank, I noticed my gold leaf electroscope, standing some



Peculiar Form of High Tension Discharge Obtained Between Two Leyden Jars Set on Brass-Bronze Paper.

distance away, near the further end of the table, under the influence of a strong charge. I discharged it and tried again with the same result, then looked at the gap, where only a silent discharge was taking place, caused by being set at the spark limit. Without disturbing anything I studied their respective positions and found the knob of the electroscope to be at exactly the same elevation as the busy end of the gap, with the latter squarely facing the former. Therein rested the secret, evidently. The oscillatory waves set up by the spark were in this way forced upon and recorded by the very sensitive instrument, which latter fact proves that a strong, unipolar element predominated in the charge (Fig. 4).

While the metal paper could by no means be clast as a conductor, this experiment demonstrates that it possesses sufficient conducting elements, however small, as to sustain a certain form of circuit; but it is, on the other hand, its feeble conducting value that makes the experiment at all possible.

The discharge rods of the spark gap, being in a vertical position, are curved in order to be capable of a wide range of adjustments. They consist of heavy, polished brass wire and terminate in 1-inch solid brass balls, well polished, as all the terminals on static instruments should be. All in all, the spark gap is a "concoction" of my own, brought about by the dire need for just such a gap (Fig. 5). No sparks will occur between the Leyden jars in this connection.

Success in static experiments depends a great deal on the nature of the connections employed. Chains or wires used for this purpose must terminate in balls or rings, respectively, with the links of the chains preferably soldered. Open ends and sharp edges are certainly to be avoided, while earth-connected or other objects not needed in the experiments are to be kept at a respectable distance from the instruments in operation.

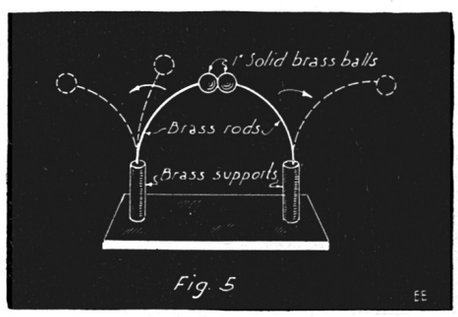
AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

CHEMICAL NAMES.

Many drugs and other chemicals have names of astonishing length, although these are generally used only by experimental chemists, shorter names being employed in the trade. Phenacetin, a popular remedy for headache, is known to chemists as acetaminophenetol. Antipyrine, which is equally popular as a headache cure, is phenylmethylpyrazolone. A few years ago a new drug was introduced as a remedy for acute rheumatism, the full name of which is sodium p h e n ylmethylpyrazolonaminomethan - sulphonate. Everyone has heard of nicotine, even if they do not happen to be smokers. Pinner, who investigated the properties and structure of pure nicotine, called it α-pyridyl-β-tetrahydro-N-methylpyrol. Some of the aniline and azo dyes and their parent substances have quite extraordinary names. Thus, the well-known dyestuff, malachite green, is prepared from a basic substance known as tetromethyldianinotriphenylmethane.

Contributed by H. J. GRAY.



Simple, Yet Extremely Flexible Form of Static Spark Gap Used by the Author in the Electro-Static Experiments Here Described.

The Chemistry of Selenium*

By Albert W. Wilsdon

History

SELENIUM was first discovered in 1817 by Berzelius, the noted Swedish chemist, as an elementary body in the deposits of Sulfuric acid chambers at Gripsholm, Sweden, where the Fahlun pyrites had been used experimentally to produce the acid, which had been previously prepared exclusively from Brimestone (Sulfur). Thus the discovery of selenium was occasioned by the independent production of Sulfuric Acid.

It is a non-metallic element, occupying the intermediate space between Tellurium and Sulfur. It may be of interest to the reader to give an explanation of how the suffix *-um* was applied to Selenium.

It has been the custom in modern times to distinguish *metals* from *non-metals* by applying to the former names ending in -um, and consequently such metals as are of more recent discovery all have names with this termination. Seleni*um* was at the time of its discovery thought to be a metal, and it consequently received a name with the terminal -um. This substance strongly resembles a metal in many of its physical properties, but its chemical relation is so closely similar to the non-metal Sulfur, that it is by general consent clast among the non-metals; it is an example of those elements which are distinguished as *metalloids*. On this account many chemists advocate the term *Selenion*.

Occurrence and Distribution:

Tho not very abundant in nature, it enters into the composition of many minerals, and has been found in the free state in certain parts of Mexico.

In combination it is found as:

1. Sulfur selenid or Selensulfur, also known as Selenic-sulfur, found at Volcano, Lipari Islands, also at Kilanea, Hawaii.

2. In Clausthalit, or Selenid of Lead (PbSe), found at Clausthal, in the Harz Mountains in Germany. Its composition is said to be: Selenium, 27.59-31.42; Lead, 63.92-71.81; Cobalt, 0-3.14; Iron, 0-.45.

3. In Lehrbachit, or Selenid of Mercury and Lead (PbSe+HgSe), found at Lahrbach and Tilkerode in the Harz Mountains. Its composition is: Selenid of Mercury and Lead represented by the formula PbSe+HgSe.

4. In Onofrit, the composition of which is: Selenium, 6.49; Sulfur, 10.30; Mercury, 81.63-98.12; which corresponds to the formula HgSe+4HgS.

5. In Berzelianit, a mineral placed by Dana in his Galena group. Its composition is: Selenium, 38.4-40; Copper, 61.6-64. It is a selenid of copper, occurring in Sweden, and in the Harz Mountains.

6. In Eucairit, derived from the Greek name Eukairos, meaning "Seasonable," Eu meaning "good," and Kairos meaning "the right point of time" so named by Berzelius, because he found it opportunely soon after the discovery of selenium. It is found in Sweden and Chile, and has the composition: Selenium, 31.6; Copper, 25.3; Silver, 43.1. It is a selenid of copper and silver, corresponding to the formula, Cu_2Se+Ag_2Se.

7. In Crooksit, the composition of which is: Selenium, 33.28; Copper, 45.76; Thallium, 17.25; Silver, 2.71; which corresponds to the formula, (CuT1Ag)Se. It occurs in Norway and Sweden.

Selenium is also found in very small quantities in meteoric iron, in some varieties of coal, and in many other minerals, especially in certain iron-pyrites, and copper-pyrites, and where these are used in the manufacture of Sulfuric acid, a red deposit containing selenium being found in the flues and chambers.

It is found in small quantities associated with sulfur, in the sulfids of Iron, Copper, Silver, etc., and more rarely in selenides, as Lead selenid (PbSe), Mercury selenid (HgSe), Copper selenid (Cu_2Se), and Silver selenid (Ag_2Se).

Preparation:

Selenium is most conveniently prepared from lead-chamber deposits. The crude material is mixed with equal parts of sulfuric acid and water to make a paste, heated to the boiling point, and treated with nitric acid or potassium chlorat from time to time until the red color disappears. This solu-

(*Continued on page* 867)

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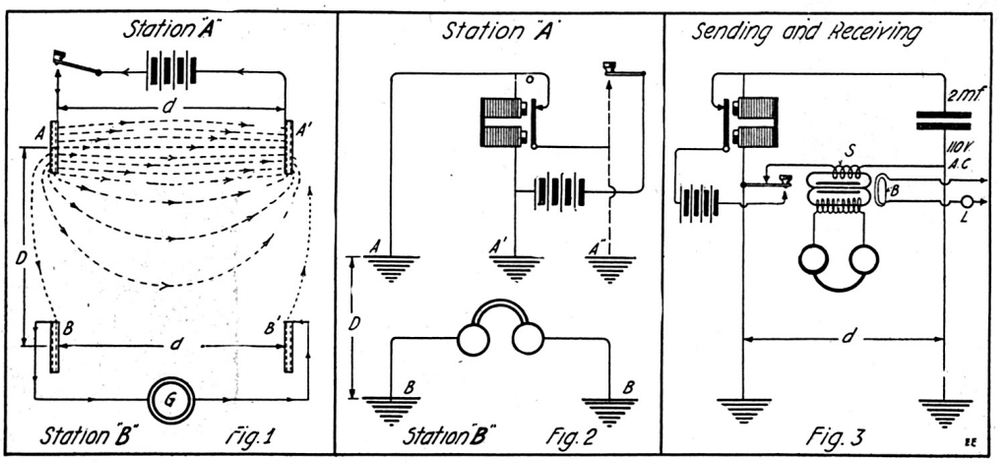
Telegraphing Thru the Earth

By Roy T. Griffith

THIS article describes a system of non-radio wireless telegraphy utilizing earth currents, which is entirely practical over short distances.

The principle is shown in Fig. 1. At Station A a battery is connected thru a key to two pipes, A and A^1, driven into the ground a few feet apart. At Station B two similar pipes are connected to a galvanometer, G. Now, when the key is deprest at Station A, the galvanometer at Station B will indicate a current in the wire connecting B and B^1. The reason is found when we trace the course of the battery current thru the ground from A to A^1. Obviously the greatest part of the current will flow directly from A to A^1, as indicated by the broken lines, spreading out but slightly in the ground. But small parts of the current will spread out over the longer curved paths shown, and some small fraction of the total current will spread far enough to reach Station B and flow from B to B^1 thru the galvanometer circuit instead of thru the ground between them. Altho this received current is very small compared with the transmititng current, it will suffice to transmit telegraphic signals between the stations without the use of conecting wires.



Some New Ideas in "Ground Telegraphy" Are Shown in the Present Diagrams and Discussion, Which Will Undoubtedly Be of Interest to the "Closed Up" Radio-bugs.

To get strong indications at the receiving station for a given distance between stations, D, we should have the distances d, our "base lines," as great as possible, a powerful transmitting battery, grounds of low resistance, and a sensitive indicating instrument.

Since the telephone receiver is very cheap and is marvelously sensitive to pulsating currents, it is desirable to use a pair of phones for receiving, and a battery and buzzer to excite the transmitting grounds. This gives the hook-up shown in Fig. 2, which makes use of the relatively high emf of self-induction developed in the buzzer coils. The grounds may be connected either across the buzzer windings (A-A^1), or the buzzer contacts (A-A^{11}) with identical results. When the grounds are good ones, connecting across the contacts usually prevents the buzzer's operation, but connecting across the windings is not so likely to do so. If difficulty is experienced from this cause, connect either a sufficient resistance or a 2 mfd. telephone condenser in one of the ground leads. The condenser will not cut down signal strength at all, but will stop sparking at the buzzer's contacts and improve its tone. The absence of sparking allows us to use much more power without injuring the buzzer. The buzzer should be arranged to give a clear high tone by soldering the contact spring rigidly to the armature and adjusting carefully. "Radiotone" buzzer will be found most excellent for this work, and its beautiful tone can be easily read thru the QRM of stray ground currents. Usually a medical coil or a small spark coil will not be found as satisfactory as a buzzer, because of their high resistance, which limits the transmitting current, and 60 cycle A. C. is undesirable because of its tone. The buzzer is ideal because it combines a low resistance with a high emf, and a good tone with ability to operate on almost any available source of current.

The phones should be of very low resistance, the lower the better. Wireless phones will give very poor results if connected directly to the grounds but are excellent if connected to the secondary of a step-up coil, the primary being put in place of the phones in the diagram.

My experiments indicate that the grounds need not be very elaborate. A pipe driven a few feet into the ground gives very good results. The two grounds should be as widely separated as conditions allow, and the base lines AA^1 and BB^1 should be parallel. It should be remembered that separating A and A^1 will practically not increase the resistance of the transmitting ground circuit, since almost all the resistance is at the surface between the pipes and the ground, but making the ratio d/D large will very much increase the ratio of the received current to the transmitted current. If the gas and water mains come into the building well apart, and are not connected in any way inside the house, they may be used as the pair of grounds, but it is usually better to use at least one separate ground. It must not be expected that using gas and water pipes at *both* stations will give improved results, for the pipes are probably connected directly together at almost every house by water heaters, etc., so that the current does not follow the pipes, but spreads out from their points of entering the ground.

Fig. 3 shows a very simple hook-up using a 6 volt storage battery, double contact key, buzzer, telephone condenser, wireless phones with step-up coil, and a "balancing coil" B. The key with the back contact is used to make the arrangement a break-in system, and to cut out the phones while sending, preventing waste of current and fractured ear drums. When the phones are connected across the grounds for receiving, a hum, sometimes very loud, will usually be heard, due to stray alternating currents. This QRM will greatly interfere with the reception of signals, but if the hum is due to 60 cycle current, and 60 cycle lighting current is available, it may be completely balanced out by placing near the step-up coil S a coil B, consisting of several turns of wire and carrying the current for a 25 watt lamp L. The position of this coil should be adjusted until perfect silence is obtained. An outfit like this employing parallel base lines of 50 to 100 feet may be expected to give good signals over a distance of half a mile. Larger powers, longer base lines, and more delicate receiving instruments will give correspondingly better results.

I think it should be clear from the above explanation that loose couplers, variable condensers, unilateral connections, and crystal detectors are very much out of place in such a system. But the experimenter will find that greatly enhanced results can be secured by the use of a regenerative Audion on the received signals, and by using a definite transmitting frequency, tuning the transmitting and receiving circuits to this frequency by properly designed iron core inductances and paper-and-tinfoil condensers.

TELEPHONE RECEIVER WORKS WITHOUT DIAFRAM.

It will be of great interest to the readers of the ELECTRICAL EXPERIMENTER to know of a way of using telephone receivers in conjunction with a high frequency buzzer connected directly across the contacts without the use of a condenser, and to still obtain the much desired high pitch but not too loud. This is done by removing the diaframs entirely from the receivers and connecting the 'phones across the contacts of the buzzer.

This will seem impossible at first, perhaps, but when tried it works admirably well, and is best explained as follows:

All telephone receivers are constructed with a permanent magnet and a soft iron core electro-magnet. When the telephone has the diafram on, in the usual way, it is attracted by the varying intensity of the magnetic field produced about the poles of the soft iron cores of the electro-magnets of the receiver. It is therefore evident, since there is always some iron left in the receiver, that this iron will be acted on to some extent, therefore manifesting itself in this case as the high pitch sound of the same frequency as the note of the buzzer. The action is usually due to the fact that the iron molecules are set into vibration by the fluctuating currents surrounding the core. It is sometimes due to loose cores or magnet laminations, screws, etc. Some years ago an account was given of a similar phenomena in the "Modern Electrics" magazine, in which case it was found possible to make a 5 h. p. motor "talk." The iron mass of the magnet frame was set into molecular vibration by varying the current thru the field coils by means of a microphone.

This also explains the reason for the "hum" produced by the core of a choke coil when connected to an alternating current. The wires as well as the molecules of the iron core are in a constant state of vibration. Contributed by E. DUSKIS.

RADIO EXPERTS WANTED!

To write up your new ideas and apparatus which have proven efficient and practical. Send us a short, clear write-up with sketches and photographs when possible. We pay good rates for all articles accepted. Address the Editor "Radio Department."

The Construction of an Experimental Electric Furnace

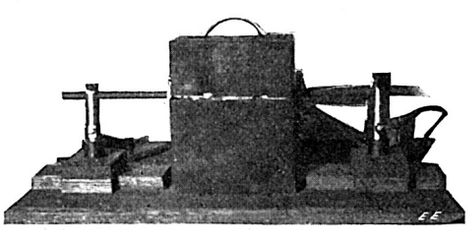
By Ralph H. Muller

IN response to the editor's appeal for practical electrical and scientific articles, I submit herewith photograph, sketch, and description of an electric furnace which I designed and constructed with the aid of a fellow experimenter. The furnace was a source of instruction and entertainment and with it the writer made many interesting experiments such as reducing refractory oxides, making alloys, etc.

The furnace can be made by anyone having access to a few tools, only one part requiring any lathe work. The sketch shows the most important details. The box in which the clay lining is placed is made of common sheet iron cut to the shape shown in Fig. 1. The larger one at the left is the lower box, the one to the right the lid or cover. The small holes for rivets, should be drilled with a No. 28 twist drill, and the box bent to shape and riveted. Little angles of sheet iron are fastened to the lower box to hold it to the base. It will be noticed that the lid or cover is provided with tabs which are bent over to keep the clay from slipping out when the cover is inverted. The upper box or cover is provided with a handle, the dimensions of which are optional. The semi-circular cut at the ends of both boxes form a hole 5/8" in diameter when the boxes are put together, and coincide with the 5/8" hole in the asbestos board shields shown at Fig. 2.

Two of these shields are required. They are cut from 1/4" asbestos board to the shape shown. A 5/8" hole is drilled equidistant from the sides and 2 5/8" from the bottom. Four holes must be drilled for 8-32 machine screws and they must coincide exactly with 4 similar holes drilled in the ends of the lower box.

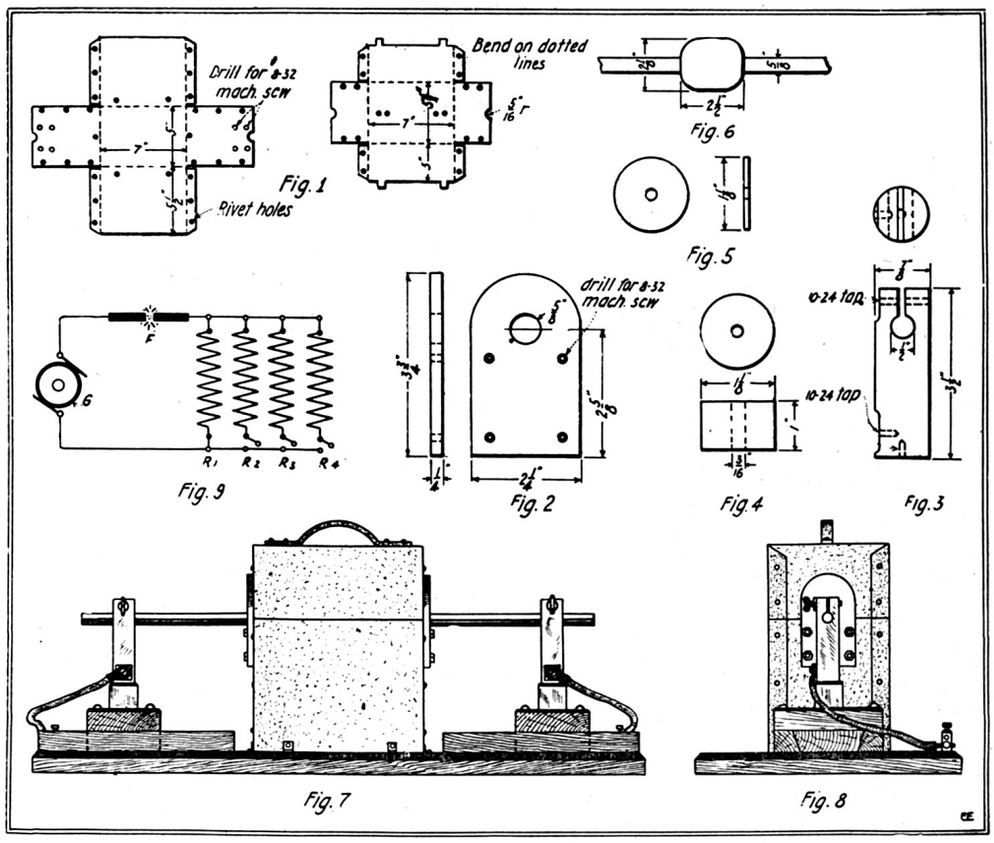
The carbon holders, Fig. 3, are made of steel turned in a lathe to dimensions shown. The 1/2" hole is drilled exactly 2 1/16" from the bottom of the piece. A slot is now sawed from the top of the piece to the hole, and a hole drilled at right angle to the slot, tapt for a 10-24 machine screw. A wing screw is used to clamp the carbon holder tight. As shown in the drawing these standards are filed flat where the machine screws are placed. The holes at the bottom are also drilled and tapt for No. 10-24 screws, the one serving to clamp the cable to it and the other to hold the standard to the slide block. Fig. 4 shows the dimensions of a fiber pillar on which the carbon holder stands; Fig. 5 shows a copper washer 1/16" thick placed between the holder and pillar.



Photograph of Finished Electric Furnace Which the Author Has Successfully Employed in Reducing Refractory Oxides, Making Alloys, Etc.

The base of the furnace is made of well-seasoned oak 25" x 11" x 7/8", and is beveled for the sake of appearances. Two slides 8" long and 3" wide at the top, having the sides beveled at 15° as shown in Figs. 7 and 8, are cut from 7/8" oak and are fastened equidistant from the sides of the base by means of flat head, wood screws, countersunk to give an unobstructed passage for the slide blocks.

These slide blocks are also made from 7/8" oak and the top pieces are cut to 4 1/2" x 3". To these are fastened, by means of round-head wood screws, two cleats 3" long 7/8" high and with sides beveled at 15°.



Many of the World's Scientific Secrets Undoubtedly Lie, as Yet Unrevealed, in the Fiery Heat of the "Electric Furnace." Moissan, the French Savant, Produced the First Synthetic Diamond in the Electric Furnace. To It Also We are Thankful for "Carborundum" and Other Abrasives. Here Is One Any Experimenter Can Make.

A 2 1/4" flat-head 10-24 machine screw is past up thru a hole drilled in each slide block, past thru the fiber pillar, copper washer, into the hole of the steel carbon holder. Leads are now provided and should be made of stranded cable, equivalent to a No. 4 wire, or even larger, and should be well insulated; preferably with an asbestos or other slow-burning insulation. The ends should be soldered to lugs, one of which is clamped to the carbon holder by means of a machine screw, the other to a binding post fastened to the base.

The next operation is to make the arc chamber. The lower box is screwed in position by wood screws passing thru the angle strips riveted to the box, and the asbestos shields are held in place by 3/8" 8-32 brass machine screws, the nuts being placed on the outside. A wooden form is turned up according to dimensions given in Fig. 6. The form is past thru the holes in the asbestos shields and clamped at both ends in the carbon holders. The extreme ends of this form will have to be trimmed down with a penknife to fit the 1/2 holes. After the ball-shaped part of the form is located in the exact center of the box, a mixture of fire-clay and water, about the consistency of dough, is packed in tightly. After it is filled, the form is carefully taken out, which operation may necessitate the removal of one of the shields. The top box or cover is then filled using the same form. After both boxes are filled and the lower one removed from the base, they are both placed in an oven (a moulder's core print oven serves admirably) and slowly baked out.

After all the moisture has been driven out, the apparatus may be reassembled. Half inch arc-lamp carbons are clamped in the carbon holders and past thru the holes in the asbestos board shields.

The furnace is then connected in a D. C. circuit as shown in Fig. 9. The writer used iron wire resistances such as are used with stereoptican lanterns. After placing suitable fuses in the circuit, close one switch and start the arc by shifting the slide blocks, then slowly close the remaining switches. The carbons require very little adjustment, for in the confined space the one carbon builds up the other and the only loss is the monoxide (CO) and dioxide (CO_2) of carbon driven off. When connected to the starting panel of a forge blower, it was possible to draw 80 amperes thru this furnace. This created a terrific roar and the clay decomposed into a glassy silicate and the writer was amused when, after ten minutes, he raised the cover and saw the arc chamber one mass of white hot bubbles of glass. A more refractory crucible for the substance is grafite, magnesite, etc.

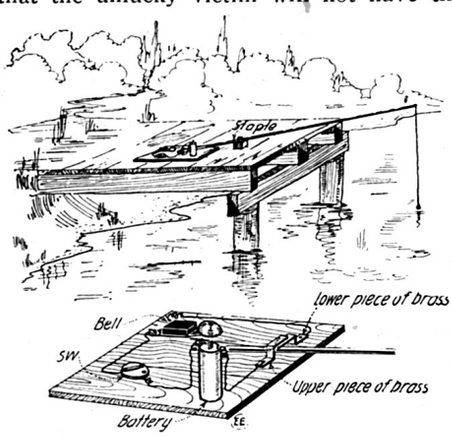
HOW TO MAKE IT

This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

WHEN THE FISH BITES THIS BELL RINGS.

The accompanying sketch illustrates a device I have used while fishing at night. It may be readily adapted for fishing thru holes in the ice also. One or two dry cells, an ordinary vibrating bell, a switch and a specially made contact device into which the fish pole fits, constitute the outfit. These parts are mounted on a board, as shown. The brass springs under which the pole rests, should be of fairly light stock, so that the unlucky victim will not have the



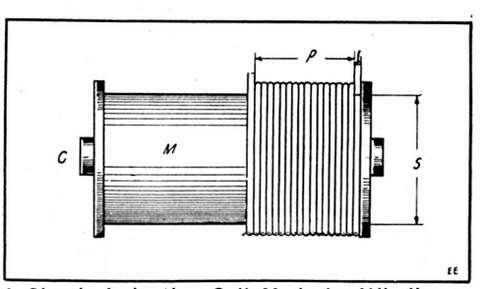
Fishing Time is Coming, Boys! Here's an Electric Alarm That Can be Rigged up to Ring a Bell or Pull Your Toe While You Doze Off on the Bank.

pleasure of pulling the line in half before the bell rings.

Contributed by
RAYMOND MURRAY.

AN EASILY MADE INDUCTION COIL.

A small induction coil may be very easily made with a high-resistance electro-mag-



A Simple Induction Coil Made by Winding a Layer of coarse Wire Over a Magnet Spool.

net (20 ohms or more) by simply winding two or three layers of coarse wire (No. 18-22) on the outside as a primary. Use the terminals of the electro-magnet as secondary leads.

A battery current sent intermittently thru the outer coil causes a magnetic field in and surrounding the magnet core. At the same time an induced current is caused in the fine wire of the inner coil.

I find this type useful as a telephone coil and with an interrupter it makes a very good medical coil. A 75 ohm magnet or one wound with seven or eight layers of No. 30 wire do about equally well.

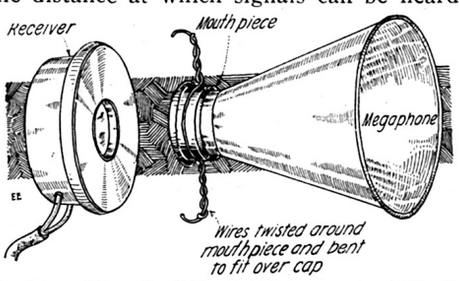
The sketch shows a part-wound diagram of my own coil, where M—Magnet (8 layers No. 30); P—Primary (2 layers No. 22); S—Secondary leads, and C—Core.

Contributed by E. BASIL LAUFER.

SECOND PRIZE, $2.00

FITTING MEGAPHONE TO RECEIVERS.

Many experimenters desire to increase the distance at which signals can be heard



An Easy Way to Attach Megaphone Horn to Telephone Receiver.

from a telephone or radio receiver by means of a megaphone. Their chief difficulty is in fastening the megaphone to the recever properly. The accompanying illustration shows a satisfactory method of overcoming this difficulty without the use of glue.

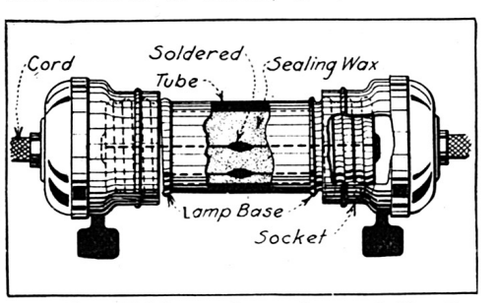
Contibuted by . F. WESLEY MEYER.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

PLUG TO CONNECT TWO SOCKETS.

This is a plug for connecting two sockets. It is constructed from 2 brass lamp base caps. The wires are connected together and soldered as shown, a card-board or



Take Two Old Screw Lamp Bases, Solder the Lead Wires as Shown, Seal up in Fiber Tube and You Have a Handy Socket Connector.

fiber tube being placed in position first. The inside of the tube is filled with sealing wax. It may be used to connect two sockets together, et cetera.

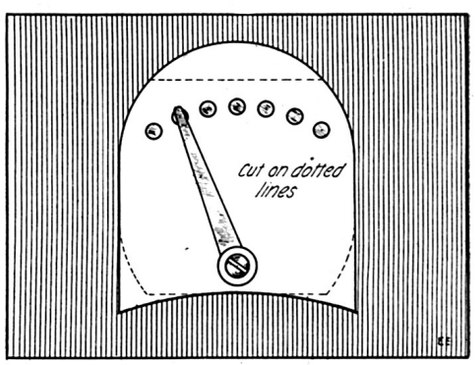
Contributed by LOUIS DROTAR.

THIRD PRIZE, $1.00

HELP! SWITCHES MADE FROM RUBBER HEELS.

Do you wear rubber heels on your shoes? Well and good—here's a fine use for electrical experimenters' old rubber heels—but not too old, mind you. Carve out a switch base as shown by the dotted lines by means of your favorite jack knife. Next—drill the proper number of holes to accommodate the switch points and blade stud. Rubber is a good insulator as we all know—besides it's a good "shock" absorber—what? Say, Brother Ohm, how 'dye get that way?

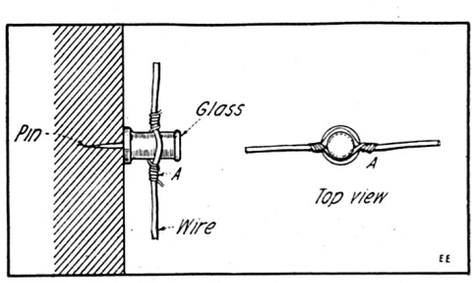
Contributed by RUDOLPH BOSSEN.



Rudolph's the Boy!! Yep, You've Guest It. A Switch Made from an Old Rubber Heel..

A CHEAP AND ATTRACTIVE INSULATOR.

A great many experimenters have big, unsightly, split knob or cleat insulators around on the walls of their rooms to support a measly No. 18 wire. Instead of this, I use "Moore" glass push-pins, which can be purchased at any book store. I used them as illustrated herewith. The live wire is held by a smaller wire "A." A small

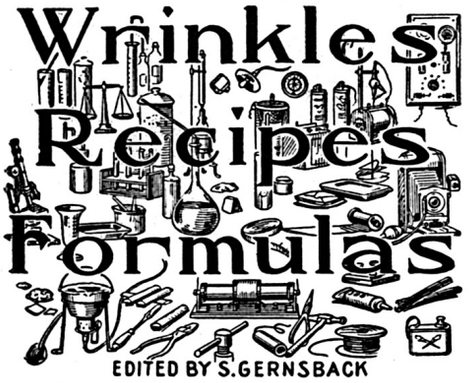


The Glass "Push Pin" Finds a New Field of Usefulness Serving as Insulators for Low Voltage Wires.

wire will slip thru the hole in the split knob and cleat insulators and look baggy, but not so with this kind of insulator. These push-pins are easily and quickly put up and if taken down do not leave a large gaping hole in the wall.

Contributed by S. T. MAUNDER.

To clean soldering iron tips badly blackened, rub the hot tip in sal-ammoniac on a brick. If corroded file smooth first.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

Experimenter's Aphorisms

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1 Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

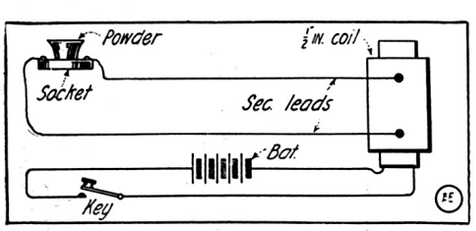
(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contends, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products.—S. G.

USING TELEPHONE MOUTH-PIECE AS FLASH-POWDER HOLDER.

An ordinary telephone mouth-piece forms a handy container for flashlight powder which is to be ignited from an induction coil or 110 volt circuit. The mouth-piece is



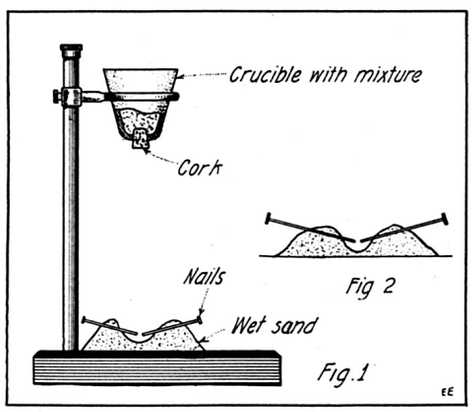
Make a Flash-Powder Holder Out of That Old Telephone Mouth-piece. A Spark Coil Ignites the Powder.

mounted upright on a block of wood with two wires attached to it in such a way that a small spark gap is left inside the mouth-piece. Over this the powder is placed. When the push button in the primary circuit is prest the induction coil spark jumps the gap, igniting the flash-powder safely and accurately. Keep your face at least 3 to 5 feet from the powder when igniting it, and don't let your hands get closer than this either, unless you want a nasty burn.

Contributed by an EXPERIMENTER.

AN EXPERIMENT WITH "THERMIT."

"Thermit" consists of a mixture of aluminum and the oxid of an element—usually



Do You Know What "Thermit" Is? This Experiment Will Get You Acquainted With It. One Use of It Is to Weld Street Car Rails.

a metal—to be reduced, as Fe_2O_3, MnO_2, SiO_2, etc. The aluminum has such intense affinity for oxygen that it reduces the oxides to their metals, giving a temperature of 3000 deg. or over.

The equation of the following is:

$$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe$$

Mix equal quantities of iron oxid and aluminum and place in a clay or sand crucible, thru the bottom of which a ½ inch hole has been drilled, and the hole fitted with a cork. Support the crucible on a ring support or a ring stand, as shown in Fig. 1. Place some wet sand in a pan, and set about 6 inches under the crucible. A small hole is made in the sand with the finger and two nails placed in it as shown in Fig. 2. They should just touch each other. A piece of magnesium ribbon is placed in the mixture in the crucible and ignited. As soon as the ribbon is lighted the cork should be removed with a pair of pliers. This must be done *quickly,* and the operator should *step aside* and avoid being burned by the spattering which is quite considerable. The molten mass will now pour into the hole in the sand and weld the nails together.

Contributed by JOSEPH GRAHAM.

GLUE RECIPES.

Glue to Resist Moisture—One pound good flake glue, melted in two quarts of skimmed milk.

Glue-Cement to Resist Moisture—Four parts good glue, 4 parts black resin, 1 part red ochre; mix with least possible quantity of water.

Marine Glue—One part of India rubber, 12 parts of mineral naphtha or coal tar; heat gently, mix and add 20 parts of powdered shellac; pour out on a slab to cool. When used, it should be heated to about 250° Fah.

Contributed by FRED WILKINSON.

A SUBSTITUTE FOR WAX COMPOUND.

When wax compound has gone up from 20 to 40 cents a pound it is not easy for the "lean-pocketbook experimenter" to encase large high frequency coils in the same. Below is a thoroly tried out system which is guaranteed to work well.

Thoroly shellac the coil three times with orange shellac. Let each coat dry well, and when the last one is ready rub well with linseed oil, place in a snug box and pour a mixture of plaster of paris and water (thick) into the box, so that it is thoroly encased. When hard it may be left in a box or taken out and polished with oils and varnishes. This idea, if followed out correctly, makes a neat and compact and truly *invulnerable* coil.

Contributed by DEWELLYN P. COTTMAN.

HOW TO "SOLDER" CARBON.

Carbon may be soldered in the following manner: First clean the place to be soldered and then cover the rest of the article, which will necessarily be submerged in the solution, with vaseline. Now, place the article in a concentrated solution of copper sulfate for a few moments, then remove it and clean; repeat this till the plating becomes plainly visible. The joint may now be soldered in the usual manner with paste and soldering iron. It is best to make the joint on a projection, because it can be plated easier. This joint may be used for the pigtails on carbon brushes, battery rheostats made of pieces of carbon connected to switch points and also to small battery carbons.

Contributed by E. S. COOKE.

CHEMICAL FIRE FORMULAS.

Put 9 drops of glycerol on a small piece of paper in an evaporating dish. Then cautiously place 6 measures of potassium permanganate on the glycerol. Keep your face away. It will burn brightly with a lilac color and carbon dioxid (CO^2) is evolved. The lilac color comes from the element potassium.

The Manufacture of Colored Fire: Mix thoroly on a piece of paper 4 parts of barium nitrate, 4 parts of potassium nitrate, ½ part of sulphur and 1 part of powdered charcoal. Pour this mixture in an evaporating dish. Apply match. The mass will take fire and burn with green fire.

Contributed by JOHN R. BROSNAN.

AN INTERESTING CHEMICAL EXPERIMENT.

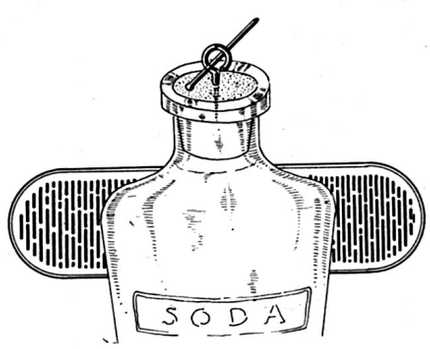
Dissolve a little cobalt chlorid in some aque regia (by heating). The mixture will be green. Add a few drops of water and it will turn red. Add three times as much water as mixture and use for invisible ink; when heated it will turn blue.

Another Invisible Ink: Dissolve equal parts of copper sulfate and ammonium chlorid in water until it becomes light green. When heated it will turn yellow.

Contributed by GEO. VAUGHAN.

EMERGENCY CORK SCREW.

Recently I had occasion to open a bottle and, not having a cork extractor, very simply accomplished my purpose by using an ordinary screw eye in combination with



A Cork Screw in a Jiffy—Simply a Nail and a Screw Eye Do the Trick.

a nail, as shown in the drawing. The use of the latter provided a better means both for turning the screw and pulling the cork out.

Contributed by JOHN T. DWYER.

Experimental Chemistry

By ALBERT W. WILSDON

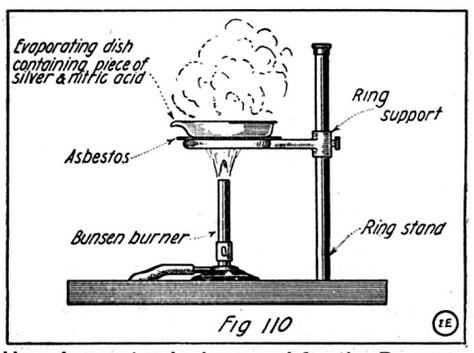
Twenty-Third Lesson

Experiment No. 113.

Silver and Copper With Nitric Acid.

PUT into an evaporating dish a piece of silver and pour over it 2 cc. (measured) of nitric acid. Place the dish on a ring stand over asbestos or iron gauze and apply heat until strong fumes begin to appear; then remove the lamp from beneath the dish and permit the action to continue as long as it will.

Mr. D. J. Thomson in the February issue

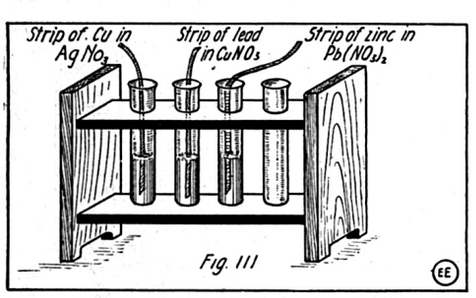


How Apparatus Is Arranged for the Preparation of Silver Nitrate.

of the ELECTRICAL EXPERIMENTER, page 699, described a method of preparing pure silver from a silver coin. The editorial note appended thereto should be read carefully.

For the purpose of illustrating the action which takes place upon the decomposition of a silver coin as described in the article above mentioned, let us mix 90 per cent of silver and 10 per cent of copper (which is approximately the composition of a 10-cent piece). Place these in an evaporating dish and add 2 cc. (measured) of nitric acid. What action do you notice first? What color has the liquid? Examine some silver nitrat and copper nitrat in solid form and in solution, and see if you can explain the color you obtained. Is the discoloration due to the copper or the silver? Are any crystals formed in your solution? If so, describe them as to shape, color, etc., and try and identify them. What does your solution apparently contain?

When the action wholly stops, remove any solid particles and add 10 or 15 cc. of water, stir it till any crystals dissolve; if the solution is not clear, filter it; pour it into a clean tube (saving a little in another tube for comparison), and suspend in the solution a copper wire (No. 9 or 10 B. & S.) made bright by running a piece of emery paper over it, or in place of the wire use a strip of copper. See Figs. 110 and 111. Note any immediate action; then allow the solution to stand, proceeding with other experiments.



Arrangement of Test Tubes for Making Observations of Actions of Different Metals on Various Solutions

At the end of half an hour or so examine the contents of the tube with care, noting the color, luster and shape of the deposit. To ascertain whether it is amorphous or crystallin, examine some of it under a microscope. Has the solution changed color? Compare with the previous solution. If so, state how, and account for it. Notice whether that part of the copper wire in the liquid has been reduced in size. Try and account for any change in the size of the wire.

Wash the deposit from the wire into a dish, return the wire, and wash the deposit several times by decantation, with stirring, and when every trace of copper nitrat solution is washed out, put away the silver in a vial and label it for future use, reserving a very little to dissolve in a few drops of nitric acid. The ionic equation for the action of nitric acid on silver is

$$3\ Ag + \overset{+}{4H} + \overset{-}{4NO_3} = 3\ \overset{+}{Ag} + \overset{-}{3NO_3} + 2H_2O + NO$$

In the above, 3 atoms of silver replace 3 hydrogen ions and become 3 silver ions; 4 hydrogen ions unite with 2 oxygen ions (thus breaking up one NO_3 ion), seizing upon enough oxygen to combine with it, forming two molecules of water and leaving a molecule of the gas-NO.

The ionic equation for copper acting on the solution of silver nitrat is:

$$Cu + \overset{+}{2Ag} + \overset{-}{2NO_3} = \overset{++}{Cu} + \overset{-}{2NO_3} + 2Ag$$

The common parts, $2NO_3$, may be cancelled. One copper atom forms a copper ion and deposits two atoms of silver. Atoms and ions thus change places.

Experiment No. 114.

Copper and Lead With Nitric Acid.

Place 2 grams of copper scraps in a dish and pour over them 2 cc. of nitric acid. If the acid is concentrated, no heat need be applied.

As in the previous experiment notice all the phenomena of the gaseous, liquid and solid products.

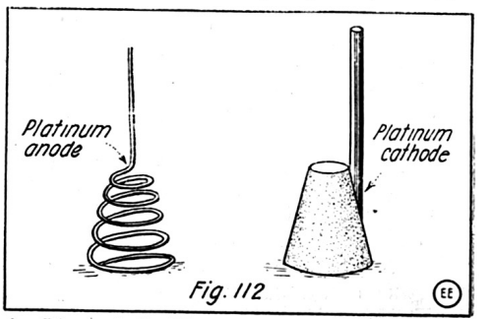
When chemical action has stopt, add 10 or 15 cc. of water and stir the mixture; then filter it (unless it is perfectly clear); save 2 or 3 cc. of it to compare as to color with that obtained by the next process. The remainder is to be poured into a narrow tube and a strip of sheet lead or a piece of lead wire (No. 9 or 10 B. & S.), made bright by filing or by sand-papering, hung in the liquid and extended to the bottom. If after a few minutes no deposit is noted, warm the tube and let it stand for half an hour, noting occasionally whether anything is depositing on the wire or at the bottom. If much free acid, due to adding an excess of nitric acid, is present, considerable effervescence will ensue. This is to be avoided by measuring the acid at the beginning of the experiment and making sure that all has reacted with the copper. If the deposit on the wire is small, it may be left for twenty-four hours.

Finally take out the wire, scrape off the deposit in a dish, and return the wire after noting the relative sizes now and at the beginning. Filter the liquid and compare its color with the sample taken earlier in the experiment. Try and account for any difference. Any deposit at the bottom of the tube should be put with that taken from the wire and washed several times by decantation, with stirring; then put it into a vial or tube and label it, except a little that should be placed in a dish and tested with a few drops of nitric acid. Think out carefully all the results obtained and make full notes, with an explanation of all phenomena and reactions; also try and reason out the two ionic equations.

Experiment No. 115.

Lead and Zinc With Nitric Acid.

Into a porcelain dish put about 2 grams of lead fiber or a piece of sheet lead, about a quarter of an inch square, and pour over

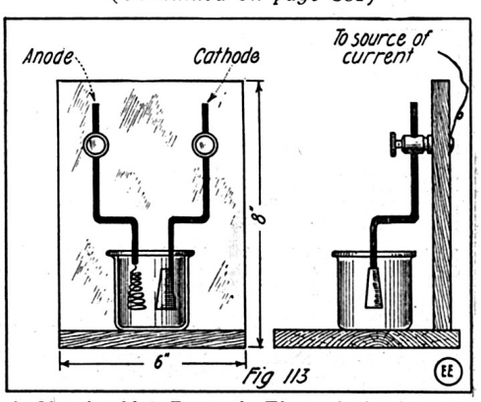


In Electrolytic Work, Electrodes of Platinum Should Be Employed Similar to the Ones Here Illustrated.

it 5 or 10 cc. of nitric acid which has been diluted with an equal volume of water. Heat the dish for five minutes; then as soon as the action stops add 10 cc. water, stir it, take out any excess of metal, and filter the solution unless it is clear. Hang in the narrow tube containing the filtrat a piece of zinc wire (No. 9 or 10 B. & S.) or a strip of zinc, leaving it for at least half an hour (or, better, for twenty-four hours). Then take out the wire, remove the residue to a dish, wash it by decantation several times, and put it into a vial and label it.

Make as close observations and take as full notes on all parts of this experiment as you did in the two previous ones. Examine specimens of lead nitrat and zinc nitrat both in solution and in the solid state. Of two elements, the one that drives the other out of solution is said to be *electropositive* to the one deposited or driven out. Of the nitrates in the last three experiments, namely, lead, silver and zinc, and hydrogen (nitric acid), arrange the elements according to their *electrochemical affinities,* placing the symbol of the *most positive* or the *plus* first, then in regular order to the *most negative* or *minus.* A negative ion is driven out of solution by a more positive ion, each ion replacing other ions according to its

(*Continued on page* 861)



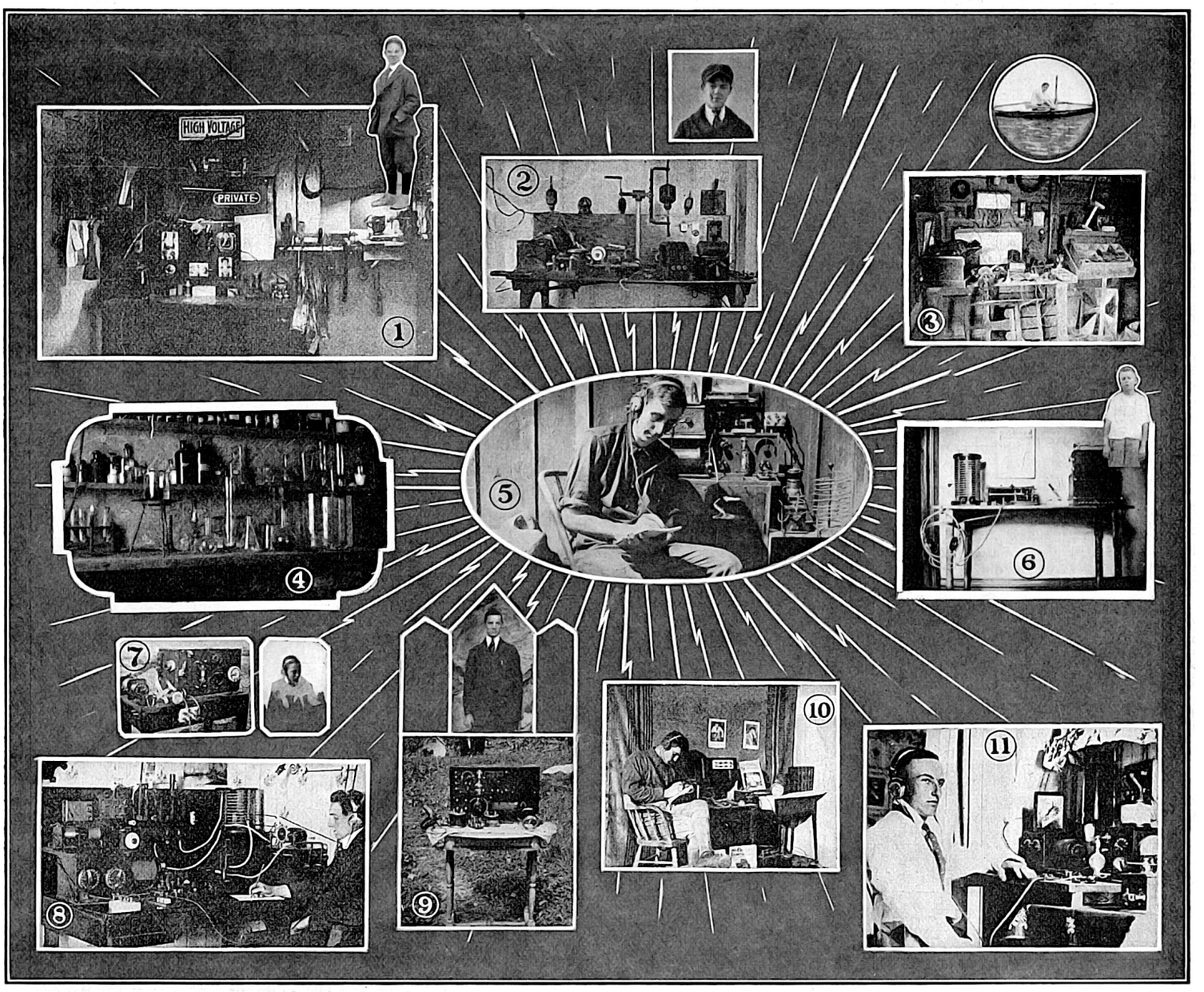
A Simple, Yet Rugged, Electrolytic Apparatus Which the Amateur Electro-Chemist Can Construct in a Few Minutes' Time and Which Is Adjustable for Different Size Bearers.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

In the March issue we publisht an interesting story with a number of excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar articles each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an anmeter, a switchboard," etc., *ad infinitum*. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab.," exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred. Tell us the facts and don't send in photos smaller than 3¼" by 4¼". They must be sharp and clear—not veritable "picture puzzles." We can read—but we are not mind-readers. Address the Editor "With the Amateurs Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.

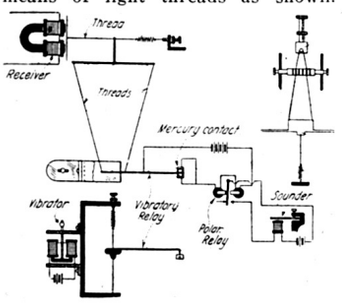
Electrical Laboratories of, 1—Gregg Toland, Los Angles, Cal. (Prize Winner); 2—Arthur Lott, Whiting, Ind.; 3—Jack Stranger, Spokane, Wash.; 4—Carroll Tobias, Bethlehem, Pa., Radio Stations of; 5—H. Gerky, Las Crosse, Wis.; 6—Earl Fraser, Denver, Colo.; 7—Fred Dickely, Brooklyn, N. Y.; 8—B. F. Wing, Idaho Falls, Idaho; 9—W. S. Wellington, Waltham, Mass.; 10—Edgar Lerew, Harrisburg, Pa.; 11—Carroll S. Miller.

LATEST PATENTS

Radio-telegraphic Recorder

(No. 1,251,473; issued to William M. Bruce, Jr.)

A system for effecting a permanent record of radio-telegraphic signals. A telephone or radio receiver has its diafram connected up mechanically with a vibratory relay member, by means of light threads as shown.

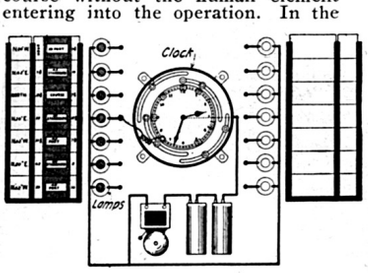


The vibratory relay is kept in the proper state of vibration by an electro-magnetic self-interrupting device. The vibratory relay armature closes a tape recorder or sounder local circuit thru a mercury cup contact. The inventor states that to obtain maximum results the vibratory relay armature should be turned so that its natural period coincides with the periodicity of the current actuating the receiver diafram.

Electric Zig-Zag Course Control

(No. 1,253,816; issued to Ernest E. Hall.)

This ingenious anti-submarine scheme for ships was described at length in the October, 1917, issue of this journal, together with later improvements whereby the device is caused to act automatically on the vessel's steering gear and thus zig-zag the ship over a predeterimined course without the human element entering into the operation. In the

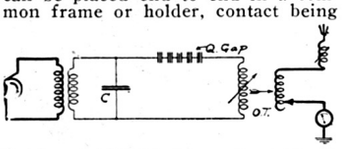


present patent the zig-zag course is plotted by the navigating officer, so that each leg of the course, consumes various increments of time. As each successive leg of the course is sailed, the helmsman removes the contact plug on the clock and sets it for the next lap. As each lap is run off, the alarm bell rings, notifying the helmsman to shift the clock contact a lap ahead and also to shift the rudder for the new direction.

Quenched Spark Gap

No. 1,1253,103; issued to Emil J. Simon.)

Quenched spark gap design for application in radio-telegraphy. The design embodies a system of building up the quenched gaps in units of say two gaps, as here shown. After assembly any number of units can be placed end to end in a common frame or holder, contact being

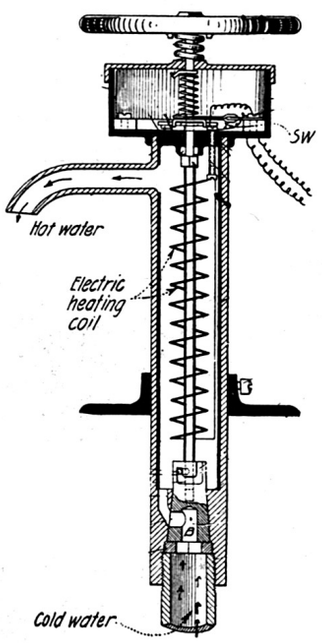


firmly establisht between the units in the manner apparent. The patentee prefers to make the gap plates of brass or other suitable material, having inset sparking surfaces of electrolytic copper. These surfaces are very close together, or about .01 inch apart. The plates of each gap unit are held together by insulating screw bushings. The plates are insulated from one another by mica or comprest paper rings.

Electric Hot-water Spigot

(No. 1,252,661; issued to Howard K. Clover.)

An instantanious electric hot-water spigot which can be attached to any pipe outlet. It may be connected with the nearest electric light socket, or floor receptacle. A turn of the handle at the top of the spigot is all that is required to turn on the water, close the electric circuit thru the heating coil (disposed vertically, as shown, in the chamber thru which the cold water passes on its way to the efflux nozzle) and get instant

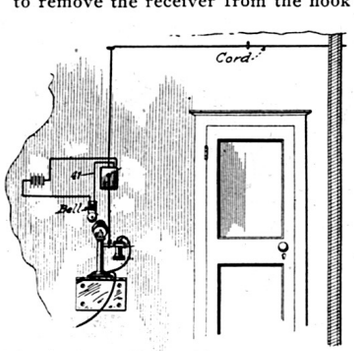


hot water. Another turn of the handle, and the water is shut off, as well as the electric current. By turning the handle a certain way, cold water may be drawn from the spigot.

Automatic Telephone Fire Alarm

(No. 1,252,665; issued to Lee A. Collins.)

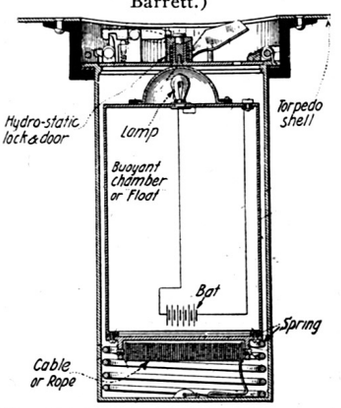
Why not transmit an alarm of fire directly over the telephone to "Central" thought this inventor, and this is what he actually does. It operates on the principle that we do not have to remove the receiver from the hook



to communicate speech or other sounds to Central. This being the case the inventor proposes to rig up a cord which, when burned or otherwise severed, causes a weight to fall —and wind up a drum which lifts the telephone hook with its receiver. Also an electric alarm bell circuit is closed; thus Central hears the bell.

Sunken Torpedo Indicator

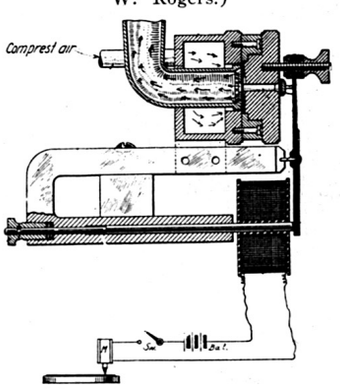
(No. 1,252,877; issued to John B. Barrett.)



Should the torpedo, as when used for practise, etc., sink to the bottom of the bay or river, a clever hydrostatic lock functions, due to the increased water pressure, opening the retaining door and liberating the "float." This is attached to the torpedo by a cable or rope; it also carries a signal lamp and battery so as to be readily seen when it reaches the surface of the water.

Electro-pneumatic Amplifier

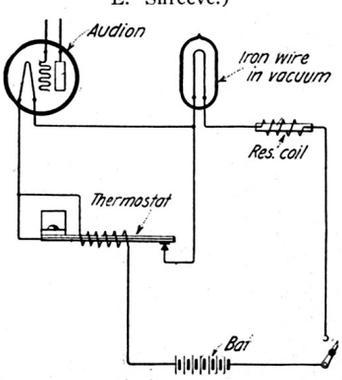
(No. 1,253,533; issued to Harrison W. Rogers.)



cuits. The voice waves from whichever source they may come, actuate a microphone or equivalent device, which is connected in circuit with a battery and the electric magnetic winding on one leg of the polarized reproducer, here illustrated. The voice fluctuations cause corresponding electric current fluctuations thru the magnet coil mentioned, these in turn acting on a balanced, pivoted armature bar. This bar controls a diafram air valve as the cut shows, causing rythmical puffs of comprest air to pass into a reproducing horn;

Audion Protective Circuit

(No. 1(252,502; issued to Herbert E. Shreeve.)

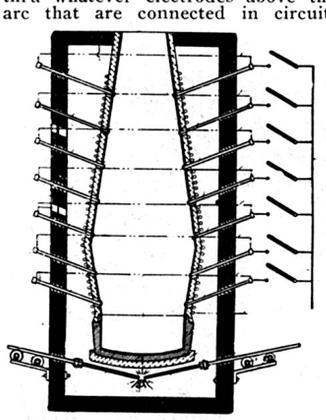


Connected in circuit with the filament and battery there is a thermostat of usual construction, also a ballast resistance element, as well as a retardation coil. The ballast is made of iron wire member in a vacuum chamber, containing hydrogen. This ballast acts to automatically regulate the current in the circuit in a well-known manner, once it is heated.

Electric Ore Furnace

(No. 1,252,635; issued to John A. Ward.)

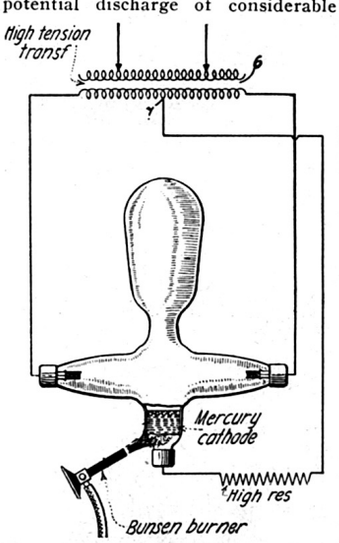
In this furnace the ore body itself is used as an electric heating element, and further, the heat generated by the controlling device is utilized, thus eliminating the usual source of waste. Conducting pencils are inserted in openings in the furnace wall at various heights as shown, any or all of which may be connected in circuit. The resistance coil (generating heat) is wrapt around the furnace. Below the crucible are the arc-forming contacts. The furnace is filled with ore from the top; it is started by closing the proper switches, springing the arc at the bottom, thence thru the resistance coil, and thru whatever electrodes above the arc that are connected in circuit.



Vacuum Regulation for Rectifiers

(No. 1,251,562; issued to H. A. Newcomb.)

This patent provides a means for regulating the degree of vacuum in mercury vapor rectifiers, and similar devices, employing a cathode of mercury or some other reconstructing, conducting material. The inventor first heats the cathode by a Bunsen burner for example; just sufficiently to vaporize a small portion of the mercury. By means of an adjustable high-potential transformer 6, a high-potential discharge of considerable



amperage is caused to flow between the anodes and thru the current-conducting bodies evolved from the heated cathode. This H. P. discharge causes intense local heating of the anodes, serving to set free occluded gases therefrom; thus lowering the vacuum.

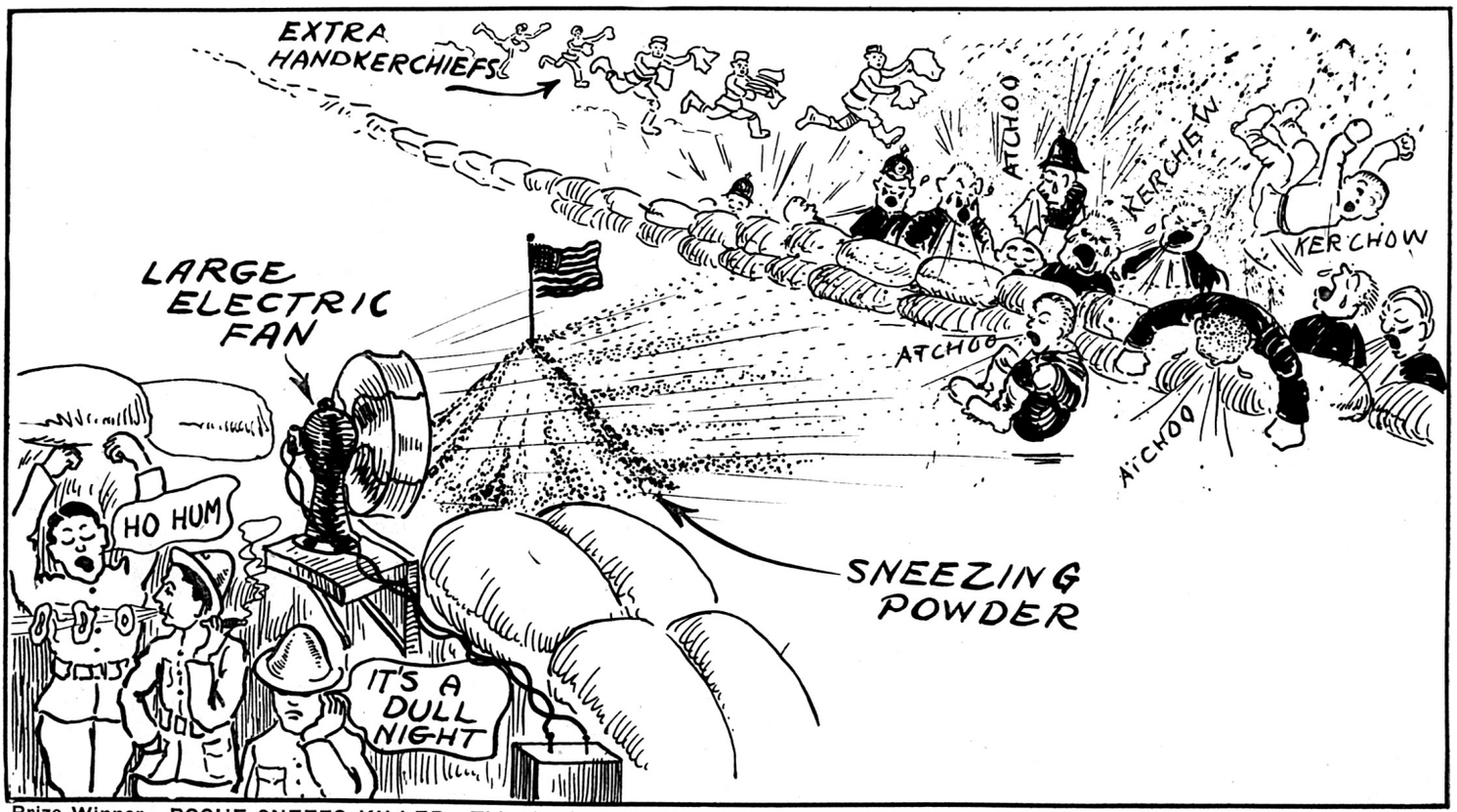
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

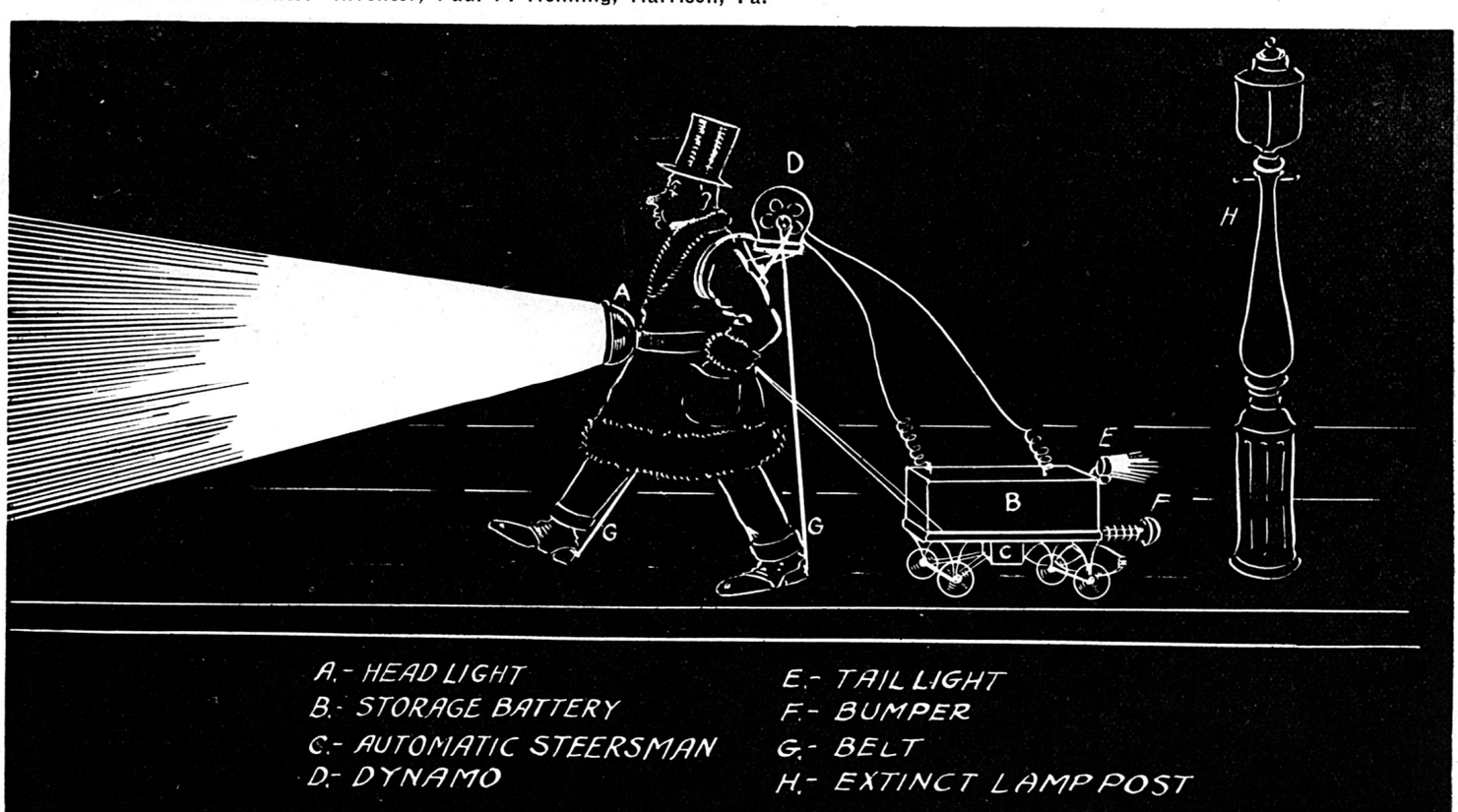
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you have $43.00!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

PHONEY PATENT OFFIZZ



Prize Winner. BOCHE SNEEZO KILLER. This simple and albeit cheap idea should find immediate favor with the Allied commanders. It's the only guaranteed, sure-fire modus operandi by which to break the Hindenburg line. On a nice dark night the Allied trench inmates deposit a fine, large heap of "sneezo" powder in no-man's land, at intervals of 100 feet. On top of the trench set a large 500 H. P. electric fan. Turn the switch. Oh! Gazuka! The Germany army sneezes itself to death—the "Reserves"—Oh! they're kept busy bringing up handkerchief reinforcements! Inventor, Paul F. Henning, Harrison, Pa.



GARFIELDIZING THE STREET LAMPS. Why wait for official orders from old "Doc" Garfield to shut off the street lights? Use my unpatented automatic, pedestrian-operated electric head-light. Its operation is simplicity itself. Every step counts, as it is geared up to spin the dynamo 50 Revs. per sec. The dynamo charges the storage battery; battery lights head-light as well as tail-light. You can't go wrong with this simple device. And it "burns no fuel"—neither does it use energy derived from fuel. We hear the "Doc" calling "James, the ice water," Inventor, Herbert N. F. Willcox, S. C. S., West Hoboken, N. J.

QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

LEARNING ARMATURE WINDING TRADE.

(909.) H. M. Rodriguiz, Calif., writes:

Q. 1. Can I learn the trade of "Armature Winding" successfully from a correspondence school?

A. 1. Armature Winding is practically a trade by itself, and it is usually the best policy to acquire this trade in an electrical repair shop or manufacturing plant where such work is performed. It is rather difficult to learn all the practical details of the art just from books.

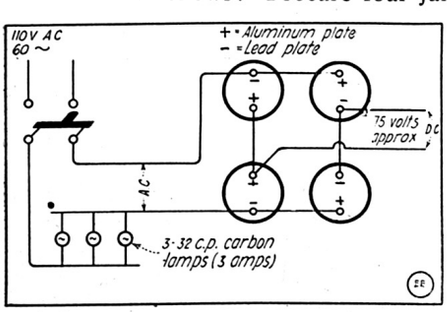
However, there is a large amount of technical detail connected with the understanding of armature winding which can be procured from a good correspondence school course, and we would strongly recommend that you get in touch with the correspondence schools advertising in THE ELECTRICAL EXPERIMENTER.

ELECTROLYTIC RECTIFIER.

(910.) W. A. Osborn, Cleveland, Ohio, wants to know:

Q. 1. How to make an electrolytic rectifier.

A. 1. The best home-made rectifier is constructed as follows: Procure four jars



Hook-Up for Four-Cell Electrolytic Rectifier Used to Convert A. C. to D. C., for Charging Storage Batteries, Etc.

having a diameter of four inches and about eight inches high, and make proper covers for these jars of wood dipt in hot paraffine. Fasten to these four pieces of wood an aluminum plate and a lead plate, the aluminum plate to be 4 x 6 inches while the lead plate should be 3 x 6 inches.

You should then proceed to fill the jars with an electrolyte made up by dissolving as much sodium phosfate as the solution will dissolve without a precipitate, when filled to one inch from the top with water. It will then be necessary to add a few drops of sulfuric acid to reduce the resistance of the electrolyte, depending upon the amount of current you wish to draw. Diagram of connections is given herewith for four-cell restifier, which rectifies both halves of the A. C. cycle.

MAGNETIC TEST FOR BRASS.

(911.) C. Robinson, Victoria, Australia, asks:

Q. 1. For a good test to determine things that are made of brass.

A. 1. One of the simplest methods of determining whether an article is made of brass or not is by means of a steel magnet. Of course, an article might look as if it were brass and be of some other alloy, but if the magnet does not exert any effect on it, it is always possible to determine in this way that the article is not iron or steel or any alloy containing a reasonable percentage of these metals.

THE USE OF "DUMMY ANTENNAE."

(912.) Harry E. Longmire, Missouri, inquires:

Q. 1. I want to know if the United States Government demands of us amateurs that we do away with our radio sets altogether, forbidding the use of "dummy antennae" and of doing radio research work.

A. 1. The U. S. Navy Department, who have charge of all radio communications and stations at the present time, do not allow any form of radio station to be put into operation with any kind of aerial, and also they do not permit the use of "dummy antennae" for the testing of apparatus, except in duly licensed research laboratories.

There are a number of articles explaining how to carry on radio communication over short distances in the September, 1917, issue, and which you will undoubtedly find very interesting.

ODD PHOTOS WANTED AT $1.00 EACH ! ! !

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," perferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to — Editor "Odd Photos," ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York City.

WHAT IS SPONGY PLATINUM?

(913.) Charles Honeywell, Gloversville, N. Y., asks:

Q. 1. What is spongy platinum and where can it be obtained, as well as its present cost?

A. 1. Spongy platinum is a form of platinum which is very sensitive to gases; i. e., when this metal is exposed to a gas it absorbs the gas considerably, causing a compression in the metal which manifests itself as heat or incandescence. Automatic cigar lighters, gas detectors, etcetera, make use of this unique property of spongy platinum.

The price of this platinum changes so often that we cannot give you its present cost, but we would refer you to any chemical supply house.

ELECTRIC MOTOR IN VACUUM.

(914.) W. R. Oliphant, Healdton, Okla., writes the "Question Box":

Q. 1. Can I run a motor in a vacuum or would it burn out?

A. 1. Relative to your question on the heating effects of an electric motor running in a vacuum, we believe that the motor could be regulated so as not to generate too much heat and thus cause destruction to itself.

In any case, if the motor did generate too much heat it would seem that it could be gotten rid of by proper cooling devices placed without the vacuum chamber, and also by providing proper means for the radiation and conduction of the heat produced.

Q. 2. Would the motor run efficiently?

A. 2. In answer to your second question, wherein you ask whether the motor might run more efficiently in a vacuum, we are certain it would not do so, and that such a system of running motors in a vacuum is impracticable, for under these conditions it would be necessary to maintain a constant vacuum by means of pumps which would have to work constantly.

From a purely academic point of view, there perhaps would be gained a little, due to the fact that the armature would run without air-resistance, but the gain is very slight.

ELECTROLYTIC INTERRUPTER QUERY.

(915.) P. Barabino, Chicago, Ill., writes:

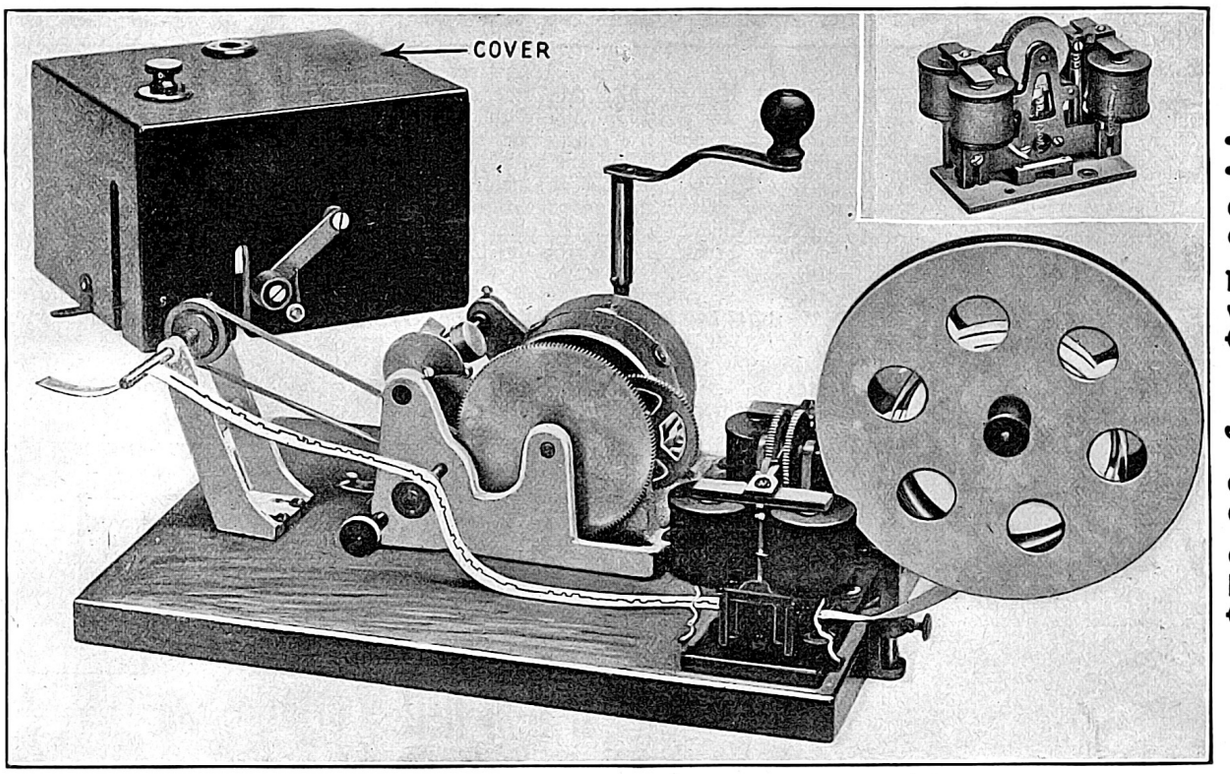
Q. 1. I am having trouble in operating a spark coil with an electrolytic interrupter. What would you advise?

A. 1. We believe the trouble to be with your electrolytic interrupter. A sure test for ascertaining this to be so is to connect

(*Continued on page* 856)

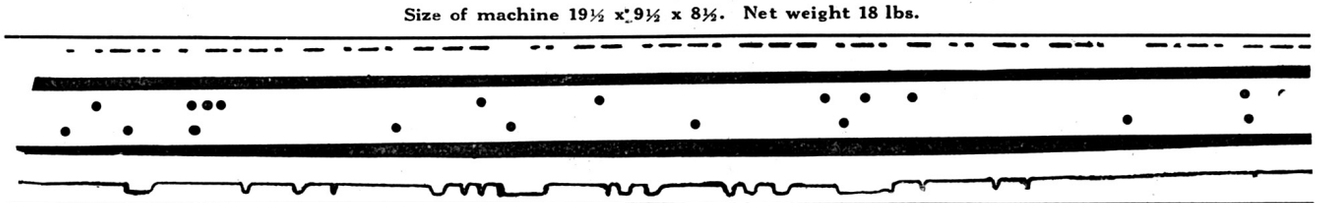
Amateurs! Experimenters!! Opportunity Extra-Ordinaire!

$70.00 for $15.00 ! !



$70.00 for $15.00 ! !

Size of machine 19½ x 9½ x 8½. Net weight 18 lbs.



These 3 tapes show how machine works.

STATEMENT BY MR. H. GERNSBACK, PRES'T:

"I have carefully read all the statements contained in this advertisement. Every word is true; nothing has been exaggerated. I believe this to be the greatest bargain,—the greatest value—that has ever been offered by my company to amateurs and experimenters, in its 14 years of existence." *ELECTRO IMPORTING CO., (Signed) H. Gernsback, President.*

HISTORY

The tape recording and perforating machine here illustrated and described is regularly manufactured by one of the largest electrical companies in the U. S. Some time ago a western telegraph company ordered a goodly quantity of these machines for their regular requirements. As we understand it, they paid over **$70.00** apiece for these recording machines. The machines were duly shipped West by Express, but the telegraph company having financial troubles could not pay the heavy express charges. Thereupon the machines were returned to New York **with added charges,** and were finally sold at auction by the express company to recover the transportation charges, as is customary. **We bought the entire lot of machines.**

DESCRIPTION

This is a standard commercial, large size, perforating, telegraph recorder. It is exactly the same machine as used by the Western Union and Commercial Telegraph Companies in their main offices. This machine requires a double contact (back stop) telegraph key and a few batteries. Pressing the key operates in turn the two sets of powerful electro-magnets, which on their part operate the two ratchet wheels. These then operate two plungers which punch the holes in the tape (see illustration of tape). By sending Morse code, the holes are punched in a certain manner. Then by feeding the tape back thru the machine and by arranging two brass contact fingers, the tape will spell out dots and dashes by means of a buzzer.

This machine has a truly wonderful spring motor. It is absolutely silent and has a centrifugal regulator speed-adjuster and stop arrangement. **At the highest speed the motor runs 18 minutes, at the slowest speed 65 minutes continuously.** Over all dimensions of machine are 19½ x 9½ x 8½. Diameter of holes punched 1/16". The width of paper tape is ½". Aluminum reel 6½" dia. The magnets measure 1½" dia. and are 1¼" high. **The net weight of the machine is 18 lbs.** Our illus. shows machine with cover removed to show motor. The small insert shows the beautiful tandem electro-magnet arrangement, the ratchet wheels and perforating equipment. All wood work is solid mahogany.

USES

What you can do with this beautiful machine:

1ST—USE AS A PERFORATING MACHINE as already described. By means of a block of wood and a few bits of brass (or you can mount them on the base of the machine) you have a regular Morse sender and receiver. You can then ask a good operator to send you a long message and you can listen to the dots and dashes as often as you wish. The tape record thus prepared will last a very long time.

2ND—AS A REGULAR MORSE REGISTER. With instructions which we supply and by using only two magnets (instead of 4) and by making a few slight changes, **which any experimenter can do,** the machine will write regulation dots and dashes on the tape. A pencil lead is used to do this. **You can then hitch an omnigraph to the recorder, and you are now enabled to read the messages by sight.** Or you can send the message yourself with an ordinary key, etc., etc.

3RD—AS A SPECIAL REGISTER. By utilizing all four magnets a special type of dot and dash can be sent (as used in cable telegraphy). See sample of writing on the tape just leaving machine, above. This record can be read just as easy as regulation dot and dash (the dot is represented by the π sign). To send such signals a slight change is necessitated which can be made by any experimenter handy with tools.

4TH—AS A TELEGRAPHONE. Every experimenter has long wished for a real telegraphone, whereby the voice is recorded on a thin steel wire, and then reproduced over a cheap style 75 ohm pony telephone receiver. By means of this machine a very efficient telegraphone can be built by any experimenter handy with tools. No expensive extras are needed; a few bits of brass and steel will do the trick.

We furnish Blue Prints and full Directions to make all the above apparatus using the recorder. We also furnish 3 paper reel tapes, standard size.

Space does not permit listing all of the many good points of the recorder. Suffice it that the machine is the most expensive commercial type, with everything of the very best.

A similar machine is listed at **$100.00** in the catalog of the Western Electric Co. We bought these machines cheap thru auction, hence the ridiculously low price. **AND EVERY MACHINE IS BRAND NEW,** has never been used, and is in perfect working order—or money back.

We have not a very large quantity of these machines on hand and as we know that there exists a big demand for this recorder, we are almost certain that we will not run this "ad" again. This is your one chance,—grab it while the machines last—**you will never see such a bargain as long as you live**—we are quite certain of it.

The size of the machine being 19½ x 9½ x 8½, the net weight 18 lbs. (shipping weight 30 lbs.) make it necessary to ship it by express or freight. We guarantee immediate shipment within 24 hours after receipt of remittance. Order at once—today—so you won't regret. If you live far away you can make telegraphic reservation. In this case we will hold one or more machines awaiting your remittance.

Price as described complete

$15.00

THE ELECTRO IMPORTING CO.

231 FULTON ST., N. Y. C.

"Everything for the Experimenter"

See also our full page ad on page 809

2 Promotions --Pay Doubled

Mr. Victor C. Harvell, one of Uncle Sam's brave flying men, wrote us the other day as follows:

Aviation Field, Mineola, N. Y.

National Aero Institute, Chicago, Illinois

Gentlemen:—I have received two promotions due directly to your valuable lessons in conjunction with my training here in the United States Government Service. I have charge of a crew of men, a hangar and six airplanes. MY PAY HAS ALMOST DOUBLED. Sincerely,

VICTOR C. HARVELL,
23rd Aero Squadron,
Aviation Branch, United States Army.

Wanted--Men!

Yes, men who know the Science of Aviation. The United States Government plans to send 30,000 flying men to Europe and has appropriated $166,000,000 for new airplanes. The airplane companies need half a million men now. You can learn this science at home during your spare time. Your training will be under aeronautical experts—men like Walter Brock, the famous aviator that won the London to Paris race.

FREE BOOK!

Just put your name and address in the coupon and we will send you our free book about the Science of Aviation and our special limited offer on our complete Mail Course. Learn all about the great opportunities that are offered you in this new billion dollar industry. Tear out the coupon and mail at once. Do it NOW!

National Aero Institute,
Dept. 7444, Morton Building, Chicago, Illinois

Gentlemen:—Please send me absolutely free and prepaid your new book on the Science of Aviation; also particulars of your Mail Course in the Principles of Aviation and special limited offer.

Name .....

Address .....

MAKE YOUR OWN GENERATOR!

We have a complete line of sturdy efficient generators and alternators from 100 to 1000 watts. We furnish these complete, or parts furnished ready to assemble with wire and instructions to wind. Send for catalogue.

ALL AT FACTORY PRICES.

BERGMANN MOTOR WORKS, 1283 NIAGARA ST., BUFFALO, N. Y.

GOOD hand generators, 110 volt, closing out at bargain prices. Crank can be replaced by pulley if desired.

GENERATORS

These are not toys but well-made machines, built for service. While they last, $3.00 each. Order quick. No catalog. ***CHEAP!***

Watson Electric Co., 867 Gas Bldg., Chicago

QUESTION BOX.

(*Continued from page* 854)

the coil across some batteries, and if it then works all right, naturally the trouble is in the interrupter.

The best way to remedy the trouble with the interrupter is to try different strengths of solution, and if this does not work, try an interrupter porcelain tube with a smaller hole. If it appears that your secondary is broken down, which you will find out by the dry battery test, then the primary voltage is too great; that is, the voltage when used in connection with the electrolytic interrupter breaks down the insulation of your spark coil.

SIMPSON MERCURY VALVE RADIO TRANSMITTER.

(916.) Walter R. Rathbun, Alaska, writes:

Q. 1. Where can I find information regarding the Simpson mercury valve radio transmitter?

A. 1. In reference to the Simpson mercury valve radio transmitter, this system was thoroly described in the February, 1917, issue of the ELECTRICAL EXPERIMENTER, page 729.

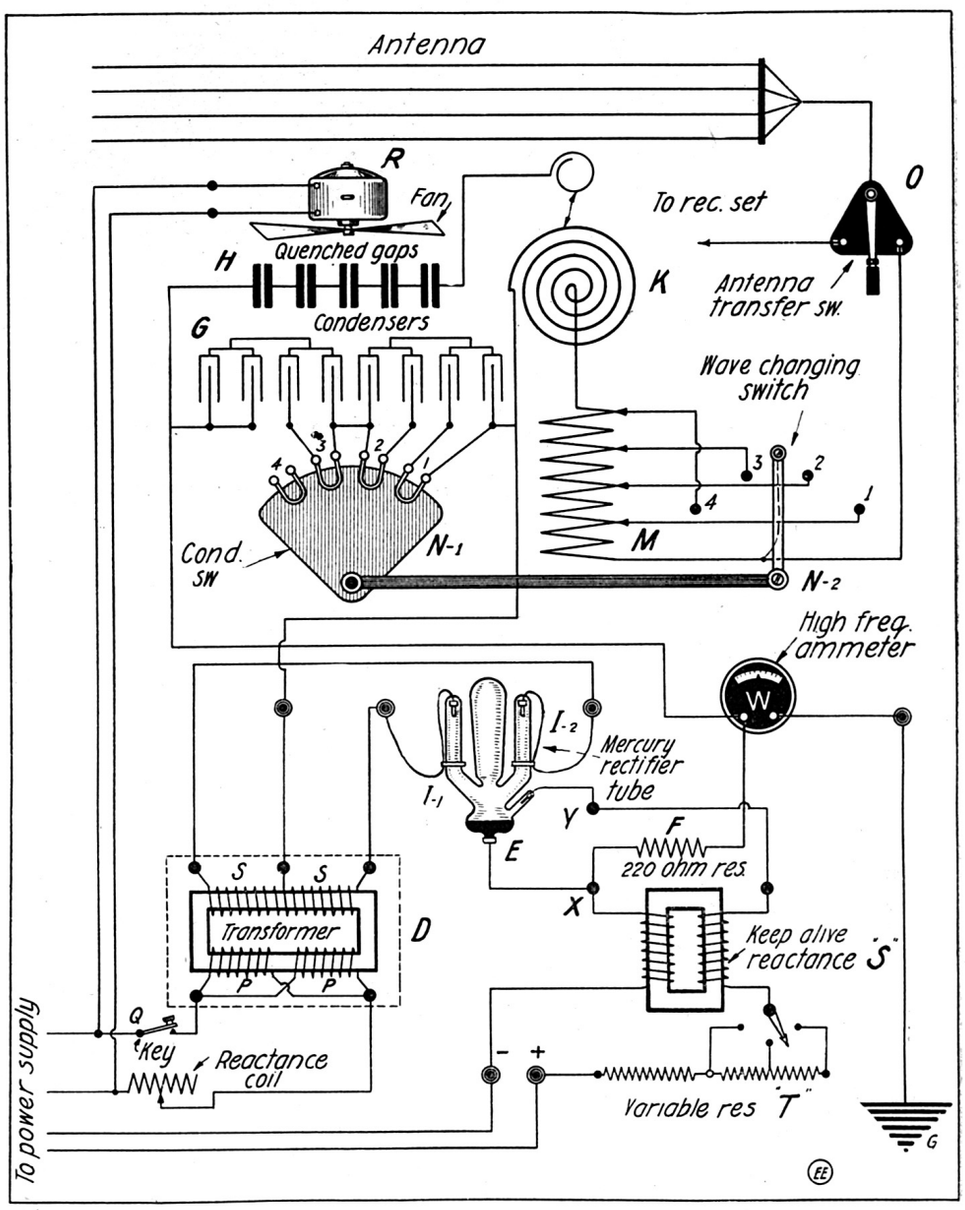
You would do well also to procure a copy of U. S. Patent No. 1,999,213, copy of which we can supply at ten cents prepaid, and in which there is considerable theory given of the Simpson Valve and its operation. We give official wiring diagram of the Simpson transmitter herewith.

DATA ON WATER FALL.

(917.) Edward Lecchis, New York, N. Y., asks for:

Q. 1. Data on water wheels, water falls, etc.

A. 1. We would advise that the formula to use in the computation of the horsepower given by a water fall, water wheels, etc., is contained in an extensive article dealing with such problems in the July and August, 1916, issues of the ELECTRICAL EXPERIMENTER, copy of which we can supply you at 20c each. This article also deals with the design and constructional details of practical water wheels of different sizes, suitable for driving dynamos, machinery, etc.



Official Wiring Diagram for "Simpson Mercury Valve" Radio Transmitting Set as Installed on Many Pacific Ocean Vessels and in Numerous Western Coast Land Stations. The Mercury Vapor Valve Acts to Transmit Only Rectified High Frequency Impulses, of Common Sign, to the Antenna.

SAYVILLE RADIO PLANT HAS NEW BUILDING.

Work was recently started on the erection of a building, 50 by 80 by 56 feet, of tile and stucco, at the big Government radio station at Sayville, L. I.

This will be used as a transmission building and connected with that will also be a similar building to be used as a machine shop and storage rooms.

MEANING OF "WIRE" AND "CONDUCTOR."

In the United States Bureau of Standards Publication No. 37 the following definitions for "wire," "conductor," "duplex" cable, and "twin" cable are given:

"A wire is a cylindrical rod or filament of drawn metal."

"A conductor is a wire or a combination of wires, not insulated from one another, suitable for carrying a single electric current."

"A duplex cable consists of two insulated single-conductor cables twisted together. They may or may not have a common insulating covering."

"A twin cable comprises two insulated single-conductor cables laid parallel, having a common covering."

And at that, we think they are still wrong, for Dr. Steinmetz says he believes that wires do not "carry" electric currents at all—they merely act as guides; the currents travel thru the ether surrounding the conductor—beg pardon—*wire*.

ELECTRICAL RESISTANCE OF THE HUMAN BODY.

Results obtained from measuring the resistance of the human body to electric currents vary from 500 ohms to 8,000 ohms and even more. According to a note by Dr. Nixdorf of Berlin, appearing originally in *Elektrizität* of that city, these enormous differences are due to the employment of defective methods. When an excessive continuous voltage is used muscular contractions and nervous excitations ensue which falsify conclusions. Experiments made by Dr. Nixdorf and Professor Brandenburg have brought consistent results. They used both direct and alternating current—in the first case at 1 millivolt, corresponding to the action of the heart; in the second case replacing the slide-wire of a Wheatstone bridge by a trough filled with a solution of sulphat of zinc, says *Revue Générale de l'Electricité*. The subject plunged his arms or his legs into salt water at the temperature of the human body and resistance was measured between the arms, between the legs and between one arm and one leg, the experiments being repeated after two weeks' time. The results are tabulated as follows:

	Resistance to Direct Current, Ohms		Resistance to Alternating Current, Ohms	
	Arm to Arm	Leg to Leg	Arm to Arm	Leg to Leg
Healthy countryman (59 years)..	1100	1400	233	350
Woman with nervous malady	1000	1200	255	455
Diabetic patient ...	1500	1700	284	434
Man (65 years) while in attack...	2000	3100	224	414
Man with softening of brain	1800	2800	299	414
Ditto	1400	1400	270	480

When the subject was apprehensive the resistance, measured with direct current, was found to be greater than when he was tranquil, 1,700 ohms from arm to arm and 1,500 ohms from leg to leg being recorded in the first state and 1,000 ohms from arm to arm and 1,200 ohms from leg to leg in the second state.

"EDISON PIONEERS"

(*Continued from page* 828)

many interesting reminiscences the gathering adjourned to meet at the Lawyers Club on Feb. 11, 1918, to celebrate Mr. Edison's 71st birthday by an informal luncheon. Over forty *"Edison Pioneers"* attended this luncheon on Feb. 11th, at which time the constitution and by-laws of the organization

How I Raised My Earnings from $30 to $1000 a week

The Story of a Young Man's Remarkable Rise as Told by Himself.

THREE YEARS AGO I was earning $30 per week. With a wife and two children to support it was a constant struggle to make both ends meet. We saved very little, and that only by sacrificing things we really needed. Today my earnings average a thousand dollars weekly. I own two automobiles. My children go to private schools. I have just purchased, for cash, a $25,000 home. I go hunting, fishing, motoring, traveling, whenever I care to, and I do less work than ever before.

What I have done, any one can do—for I am only an average man. I have never gone to college, my education is limited, and I am not "brilliant" by any means. I personally know at least a hundred men who are better business men than I, who are better educated, who are better informed on hundreds of subjects, and who have much better ideas than I ever had. Yet not one of them approaches my earnings. I mention this merely to show that earning capacity is not governed by the extent of a man's education and to convince my readers that there is only *one* reason for my success—a reason I will give *herein*.

One day, a few years ago, I began to "take stock" of myself. I found that, like most other men, I had energy, ambition, determination. Yet in spite of these assets for some reason or other I drifted along without getting anywhere. My lack of education bothered me, and I had thought seriously of making further sacrifices in order to better equip myself to earn more. Then I read somewhere that but few *millionaires* ever went to college. Edison, Rockefeller, Hill, Schwab, Carnegie—not one of them had any more schooling than I had.

One day something happened that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter which was of little consequence. I knew in my heart what was the right thing to do, but something held me back. I said one thing, then another. I couldn't for the life of me make the decision I knew was right.

I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to *discover* myself. Along towards dawn I resolved to try an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions—that when I had an idea I would have sufficient confidence in myself to put it "over"—that I would not be "afraid" of myself or of things or of others.

With this new purpose in mind I applied myself to finding out something more about the will. I was sure that other men must have studied the subject, and the results of their experience would doubtless be of great value to me in understanding the workings of my own will power. So, with a directness of purpose that I had scarcely known before, I began my search.

The results at first were discouraging. While a good deal had been written about the memory and other faculties of the brain, I could find nothing that offered any help to me in acquiring the new power that I had hoped might be possible.

But a little later in my investigation I encountered the works of Prof. Frank Channing Haddock. To my amazement and delight I discovered that this eminent scientist, whose name ranks with James, Bergson and Royce, had just completed the most thorough and constructive study of will power ever made. I was astonished to read his statement, "The will is just as susceptible of development as the muscles of the body!" My question was answered! Eagerly I read further—how Dr. Haddock had devoted twenty years to this study—how he had so completely mastered it that he was actually able to set down the very exercises by which anyone could develop the will, making it a bigger, stronger force each day, simply through an easy, progressive course of training.

It is almost needless to say that I at once began to practice the simple exercises formulated by Dr. Haddock. And I need not recount the extraordinary results that I obtained almost from the first day. I have already indicated the success that my developed power of will has made for me.

I understand that Professor Haddock's lessons, rules and exercises in will training have recently been compiled and published in book form by the Pelton Publishing Co. of Meriden, Conn., and that any reader who cares to examine the book may do so without sending any money in advance. In other words, if after a week's reading you do not feel that this book is worth $3, the sum asked, return it and you will owe nothing. When you receive your copy for examination I suggest that you first read the articles on: the law of great thinking; how to develop analytical power; how to perfectly concentrate on any subject; how to guard against errors in thought; how to develop fearlessness; how to use the mind in sickness; how to acquire a dominating personality.

Some few doubters will scoff at the idea of will power being the fountainhead of wealth, position and everything we are striving for, and some may say that no mere book can teach the development of the will. But the great mass of intelligent men and women will at least investigate for themselves by sending for the book at the publishers' risk. I am sure that any book that has done for me—and for thousands of others—what "Power of Will" has done—is well worth investigating. It is interesting to note that among the 225,000 owners who have read, used and praised "Power of Will" are such prominent men as Supreme Court Justice Parker; Wu Ting Fang, ex-U. S. Chinese Ambassador; Lieut.-Gov. McKelvie, of Nebraska; Assistant Postmaster-General Britt; General Manager Christeson of Wells-Fargo Express Co.; E. St. Elmo Lewis; Governor Arthur Capper, of Kansas, and thousands of others.

As a first step in will training, I would suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the form below, if you prefer, addressing it to the Pelton Publishing Company, 30-H Wilcox Block, Meriden, Conn., and the book will come by return mail. This one act may mean the turning point of your life, as it has meant to me and to so many others.

PELTON PUBLISHING COMPANY
30-H Wilcox Block, Meriden, Conn.

I will examine a copy of "Power of Will" at your risk. I agree to remit $3 or remail the book in 5 days.

Name .....

Address .....

....

—"LEARNELECTRICS"—

DEPENDABLE KNAPP ELECTRIC SPECIALTIES

All basic truths and principles made clear and fully demonstrated.

Complete Electrical and Experimental Laboratory

A choice collection of instruments, materials and interchangeable parts with which numerous electrical machines may be constructed and a thousand experiments performed.

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Instruction Book

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If your dealer cannot supply you, order direct Write for free catalog of electrical motors and specialties from 10c up.

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or more-easily and quickly-selling this wonderful automatic gas lighter-an indispensable household article-does away with dangerous and inconvenient matches-sells itself-bought on sight write for sample.

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A few hours interesting work saves many dollars and gives you a machine exactly to suit your ideals We furnish motors, tone arms, case material, blue prints and full instructions. Plays any record. You can make fine profit building phonographs for your friends.

SAVE OVER HALF

Write Today for Our Free Blue Print Offer. Agents wanted for our ready built Choraleons

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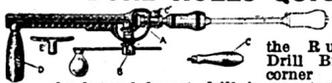
BORE HOLES QUICKER



and with less elbow grease. Use the Rusby Extension Drill Brace. A perfect corner brace, extension chuck, and breast drill in one tool. Instantly adjusted to various lengths and speeds. Chuck holds round and square shank drills and bits. Often pays for itself in one job. **Special Price, $3.60 Prepaid Via Insured Parcel Post**

Thousands in use. Sold on money-back guarantee. Send check or money order for one TO-DAY. Start NOW to same time and strength—they're valuable.
HOWARD R. SMITH, 234 Harrison St., Nutley, N. J.

Learn Watchwork, Jewelrywork and Engraving. A fine trade commanding a good salary, and your services are always in demand. Address HOROLOGICAL Department, Bradley Institute, Peoria, Ill., for our latest catalog

Big Profits Charging Auto Storage Batteries HB Chargers bring owners $40 to $60 clear profit every month. This money-maker complete for $15 cash, balance in 8 monthly payments of $20 each. Money-back satisfaction guarantee. Mail this ad with name for full particulars. **HOBART BROS. CO., Box E-44, Troy, Ohio.**

were formally adopted and various steps taken to further the aims and objects of the *"Pioneers."* These steps among other things embraced the erection of a memorial on the Lincoln Highway where it is to pass Mr. Edison's old home and laboratory buildings at Menlo Park, N. J.; the coöperation with the Edison's Association of Illuminating Companies in the formation of an Edison Museum, the preparation of a Biographical and Historical Volume to be presented to each member and certain other important matters of which it is inadvisable to speak at the present time. It was also decided that the *"Edison Pioneers"* should be perpetuated by making the members' descendents eligible to membership. A birthday telegram of congratulations and hearty well wishes was sent to Mr. Edison, whose absence in Florida made it impossible for him to be present and after addresses by President Francis R. Upton and others, the party adjourned.

Among the men already identified with the *"Edison Pioneers"* are Francis R. Upton, Orange, N. J.; Sydney B. Paine and W. S. Andrews, Schenectady, N. Y.; F. B. Potter, Charles A. Benton, Fremont Wilson, William J. Hammer, Edwin W. Hammer, Frank S. Hastings, F. S. Smithers, Frank S. Hastings, F. A. Wardlaw, H. A. McLean, Charles S. Bradley, Peter Weber, C. Roch, Arthur S. Reves, A. C. Pointier, W. Pelzer, C. W. Kiddle, Alexander Mungle, W. A. Donshea, A. S. Campbell, Henry Stephenson, New York; Philip S. Dyer, Easton, Pa.; Geo. S. Grower, Ansonia, Conn.; E. G. Acheson, Niagara Falls; Charles Wirt, Philadelphia, Pa.; John W. Lieb, New Rochelle; A. O. Tate, Philip Klein, Montreal, Can.; John Ott, William Meadowcroft, C. N. Wurth, W. S. Gilmore, Orange, N. J.; Samuel D. Mott, Passaic, N. J.; Samuel Insull, Henry M Byllesby, Chicago, Ill.; P. B. Shaw, Williamsport, Pa.; William M. Brock, Paterson, N. J.; Wilson S. Howell, Pleasantville, N. J.; John W. Howell, George F. Morrison, Newark, N. J.; M. F. Moore, Roselle, N. J.; William Carman, Menlo Park, N. J.; Schuyler S. Wheeler, Ampere, N. J.

HEALTHFUL HEATING OF THE TISSUES BY ELECTRICITY.

(*Continued from page* 824)

In other words, a spark or series of crackling sparks, crash across the spark gap. The arrangement then is such that the Leyden jar is kept filled with electric stress equal to the force necessary to break down the distance of the spark gap. The wider the space, the greater the stress in the jar. The greater the voltage, the higher the amperage.

In the ordinary high frequency machine the patient is placed between the terminals of the gap. When a patient is so placed, he shares in the *oscillations* of the current. These, when strongest, are like a spring, which, when released, overshoots its mark. They are like a pendulum, strongest at the beginning and gradually come to rest.

Electric particles or *current-like* particles or *waves* of light, travel at about 186,000 miles a second. In 1/120 of a second the current covers 1,550 miles. The inside of a Leyden jar measure 3 inches from the center to the sides. The space is therefore covered several million times during each alteration of the primary current. Since the secondary alterations are at least ten times more, there may be millions upon millions of alterations a second.

Here you have a simple A. B. C. explanation of the high frequency electric current, which is successfully used to make heat and also to heal certain sorts of human ailments, such as arthritis of a particular type.

ETHERIC MEMORIES

(*Continued from page* 838)

get finished, in fact every thing in the line of pasteboard from oatmeal boxes to hat boxes disappeared, not to mention anything about the paint and varnish, the earmarks of which were evident almost everywhere. The door bell received another calling and said bell disappeared instantly, of course it was essential that the annunciator wire leads should also vacate, for without them I would have had no primary. Pop only discovered this after having to knock a few window panes in to let us know that he was trying to get into his own house. Next in line came the push button, last but not least, for it was put to very good use, having arranged a perfectly good test, (32 cp light in series with 110 AC). Of course, it made no difference whether the detector was adjusted or not, just so I had my hand on the frame of said button I could hear a loud click in the phones,—it was really a wonderfully designed detector, you see it never lost its adjustment and still I remember of sitting hours all through the local stations schedules without hearing a sound. I remember once of getting a slight click in the phones, just before one of my friends came running in and reported that a tree had been struck by lightning just two blocks north of the house.

By this time I had been reading considerable literature in regards radio and had been pronounced incurable by old Doc. Bugs from Bugland, who stated that he expected to see me one day as a very prominent leading engineer, owing to the fact that he was present the day I short circuited my detector in order to reduce the resistance in the closed circuit, thereby lowering the decrement; truly the tuning qualities must have been increased considerably, in fact it was so sharp that I was not able to get the blooming thing set on any particular tune, nor did I hear anyone during that entire long dreary month of agony, which time it took to complete these demented experiments. I decided to return to the old circuit, feeling perfectly satisfied to wait until I had mastered the art of tuning, before trying any more highbrowed stuff.

Hurrah! Hurrah! More experiments for kid bugs, AH then came the Potentiometer, well, in short, from the following you will find that it is advisable that the inventor's name should be kept MUM from my Dad. Taking a good squint at the specifications I began to lay my plans, immediately visited Papa's store and work shop, and quietly removed as much resistance wire as I could from the starting box, but the worst part of it was when the electricians told Pop that Damnable lie about motor trouble and they soaked him forty dollars for MOTOR repairs which I am quite sure consisted of a complete wiping off of the commutator and restoring the resistance in the starting box. Well did I feel like a thief? NAW, not at all. Forty cents of resistance wire, and I had moved the decimal point two places to the right for Dad.

Of course, after the above was accomplished it was essential that I have a sending set, and I did not lose any time getting this, for Father's shop was shy a few snap switches, fifty feet of No. 14 DBRC, a DPST switch and his desk fan which was used for my rotary. Now Dad never went to work at night, so I was quite sure that he would not discover these missing links, but, however, he did go one night and what

a night it must have been for him, but OH! what a night it WAS for me; well do I remember in trying to retreat from the razor strap with the phones still clamped tightly on my head. In my excitement I sat on the key with my right hand holding tightly on the spark gap reaching for the door with the left, at the same time busily engaged in studying the least path of resistance. Oh! yes, it is great to have been a pioneer; in fact it's the only way. It was only thru the *Modern Electrics* then, and the ELECTRICAL EXPERIMENTER NOW that got my start and which allowed me the above pleasures. Well, Bugs, I'll not keep you from your work any more, connect them in series or in parallel, I don't care, you know what you want. E. T. J.

UTILIZING BURNT-OUT LAMP BULBS.

(*Continued from page* 833)

tain pure hydrogen; the other, pure oxygen gas. The former is connected to the negative, the latter to the positive pole of the battery.

Nearly every experimenter wishes to possess a good electroscope. One can be readily made from a burnt-out lamp bulb as is shown in Fig. 7. Take an ordinary bulb and cut off the top as explained in the preceding articles. Leave one lead wire which *must* be the one going thru the central connection as shown in illustration. By means of a long pair of tweezers, bend this wire around to form a small hook. Now take a strip of gold leaf 2 inches long, ⅛ of an inch wide, and fold once. This gives us two strips joined at the center, each 1 inch long. (See illustration.) The writer, who has had quite a good deal of experience with gold leaf, has taken a peculiar dislike to the same, as it is nasty material to handle, adheres to the fingers and is a general nuisance all around. For some years past he has used a gold leaf substitute, which can be easily handled, and which works just as well if not better than gold leaf.* The substitute gold leaf can be readily fastened to the central lead wire, as, for instance, with a bit of thick shellac; or it may be simply hung loose; but we believe shellac to be the better method. Ordinary fish glue may also be used, and it proves quite satisfactory. In that case, simply apply a little of the glue by means of a wood splinter to the hooked lead wire. The gold leaf can then be hung on the little hook of the lead wire, and will adhere there readily. After all is finished, the bulb is secured to two wooden blocks as shown in the illustration, the lower block carrying a piece of felt to support the bulb, while the upper ring-like clamp simply holds the bulb in its upright position. Four pieces of felt may be placed between bulb and ring, so as not to crush the glass. Rubber feet at the bottom of the base complete the apparatus, which are quite necessary. If now, for instance, an ordinary rubber fountain pen be rubbed on the sleeve, thus electrifying it, and after it is brought near the metallic top of the lamp, the two gold leaves will diverge. The stronger the charge, the further the leaves will diverge. They can be made to diverge quite violently if an ordinary piece of blotting paper is taken and strongly rubbed over your knee. This strongly electrifies it, and the leaves will diverge violently; if they are long enough they will touch the wall of the bulb.

In the next idea is shown how the experimenter can make an efficient Leyden jar (condenser) by means of a discarded lamp bulb. Take a bulb and break off its tip under a solution of either strong salt water

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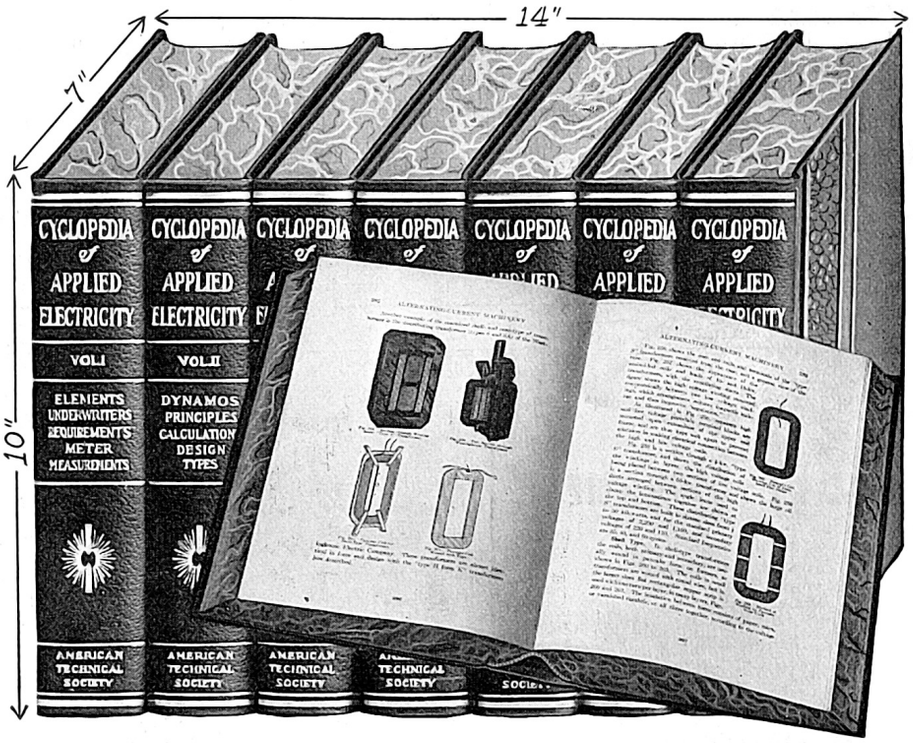

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or acidulated water, one part acid, four parts water. The solution will rush into the bulb as mentioned in the "barometer" experiment. It is, however, not necessary to quite fill the bulb. In other words, three-quarters full will be sufficient. As will be noted from the illustration, the two lead wires can remain after the filament has been broken off. Nothing further remains to be done except coating the outside of the bulb by means of tin foil which may be shellacked to the bulb. In order to make a good connection, our detail illustration shows how this can be accomplished. A piece of copper foil about 1 inch long and ¼ inch wide is soldered to a copper wire. This copper foil is shellacked against the glass of the bulb, and the tin foil is then wound around the bulb over the copper foil. No shellac should come between the copper foil and the tin foil. Otherwise a bad connection results. The tin foil should reach up as high as the solution goes, and should be on the level with the latter. It does not matter how far the tin foil reaches down, and this is up to the constructor. In our illustration we have only shown it three-quarters way down, but the tin foil could go still further down. Of course, in that case, the copper foil would be moved further down also.

In order to keep the wire from tearing out the tin foil, a stout rubber band may be slipt over the bulb (not shown in illustration). This rubber band will hold the wire in a satisfactory manner.

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INTENSIVE TRAINING FOR THE SIGNAL CORPS.

(*Continued from page* 836)

wireless and induction, telephone and buzzer. He must also learn to handle complete wire and radio companies with precision in various formations and also the means of transportation provided for each, motor truck, motor cycle, wagon or pack mule. Gas engines alone hold a prominent place in the course. Trucks and engines are taken entirely apart and replaced for instruction. It seems incongruous that the pack mule should, in this age of motors, come in for his share. He holds a place that it has been found cannot be filled as efficiently by machine. He has always had a warm place in the hearts of the old soldier, especially the cavalryman and even now the old packer and his mules are worth their weight in gold. Streams, mountain, roads or no roads, look alike to the patient mule. You may be sure that he will find his place even in extremely modern warfare. I cannot recall a more welcome sight than a pack mule, commanded by a catholic priest, loaded to the gun'ls with grub, making port in rear of the trenches on San Juan after a hard days work and nothing to eat or drink. In the signal corps he now carries a portable radio set consisting of a hand-power generator of about one quarter k.w., operating chest and sectional mast. The entire outfit can be unloaded, set up and placed in operation in about eight minutes and loaded again in less time. It is extremely useful in keeping a fast-moving cavalry or artillery outfit in touch with headquarters or communicating with other and detached outfits and across country where, owing to mountains or water, it is impracticable to string or lay wires. Much dependence cannot, however, be placed in radio as a means of communication on account of likelihood of "jamming" by the enemy in emergencies.

The greatest demand for our signal men will be in connection with the building maintenance and operation of more or less permanent telegraph and telephone lines between the base of operations and the extreme front and an intercommunicating system at the latter point. Also in the control of railway train movements in the zone of operations.

When the young officer is finally assigned to a company and is in the theater of military operations he will find himself confronted with problems on every hand, maintenance of communication, maintenance of health and discipline of the men and he must know his business thoroly.

Let us suppose that the commander of a division to which his company has been assigned calls him into a conference, at which a plan has been mapt out for a battle the following day, and says, "Captain, I am going to move a battery of field artillery to such a point, can you keep these headquarters in communication with it?" The impulse would be to take the risk and say "Yes." Possibly the success of the entire operation rests upon his being able to keep up such communication and his reply should be made after full consideration of the men and material under his control, of the country over which he is to work and every possible exigency which may arise and when making his reply to the commander should lay before him all his knowledge of the limitations so that he may know just what can be absolutely depended upon and when he goes to battle know just where his weakness lies, if this cannot be remedied, as well as his strength.

The signal corps, unlike any other branch of the military service permits of a great amount of initiative on the part of the officers, whatever their rank may be, and, if he is capable and wideawake and knows his business he will have unlimited opportunities to distinguish himself. Even a single enlisted man, crawling from shell hole to shell hole, unreeling his little buzzer wire may be the means of saving an entire detachment, which has gone far ahead and is cut off by a barrage from retreat and who need a protective fire in front until reinforcements can come up, from annihilation.

Study, practise and physical exercise makes them fit for the opportunity when it comes. It is wonderful to see how the students progress; their studies are new and interesting and their incentive puts life and snap in every movement so that in two or three months they compare favorably with regulars in everything but experience and in that terms are about even as the present war presents conditions that are new to all and feeling, if any exists between them will be laid aside on the other side for there will be room at the top for all.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 850)

valence. The valence of copper being 2, each copper atom displaces two silver atoms or ions. This is shown by the equations. A list of all the metals can be made showing their electrochemical affinities.

Experiment No. 116.

Into 5 cc. of water put 1 gram of copper bromid. Heat, if necessary, to dissolve it. Notice the color. Next add 5 cc. more of water and note any change of color. Then dilute the solution still further till you see a marked change of color. Try to explain the three results by the ionic theory.

Experiment No. 117.

Prepare a saturated solution of sodium chlorid (common table salt) by heating the salt in 10 cc. of water until no more will dissolve, then cooling and pouring the solution — having no precipitat — into another tube. Pour into the sodium chlorid solution 10 cc. of hydrochloric acid. Note result and try to find an explanation by means of the ionic theory. Also determine what stage of the experiment illustrates equilibrium. Do the same with sodium chlorid and barium chlorid. The ionic theory explains only part of the precipitat.

Experiment No. 118.

The Electrolysis of Hydrochloric Acid.

Obtain a concentrate solution of hydrochloric acid and electrolyze the acid by using the apparatus described in the ELECTRICAL EXPERIMENTER for October, 1916, Experimental Chemistry, Lesson 5, page 422, or Fig. 113. Note and account for the relative volumes of the two products.

Experiment No. 119.

Estimation of Copper.

Weigh about 1.5 gram of recrystallized copper sulfat into a beaker and dissolve in 200 cc. of water. About 2 cc. strong nitric acid is added (if the copper is to be separated from other metals, a larger quantity of nitric acid must be added) and the mixture gently stirred with the platinum wire which is to be employed as the anode; this is then left standing in the beaker. The platinum cone, which has been perfectly cleaned and carefully weighed, is then lowered into the beaker over the projecting end of the anode. In *electrolytic work,* and especially in *analysis,* it is of the utmost importance that the platinum cathodes which are used should be scrupulously clean, and free from *even the slightest trace of grease,* even to such an extent that would be *contracted by touching them with the fingers.* The two electrodes are then fastened to their respective supports, which may be similar to the apparatus shown in Fig. No. 113. They should not

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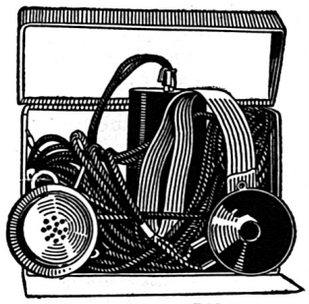

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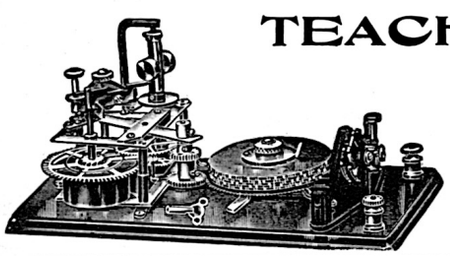

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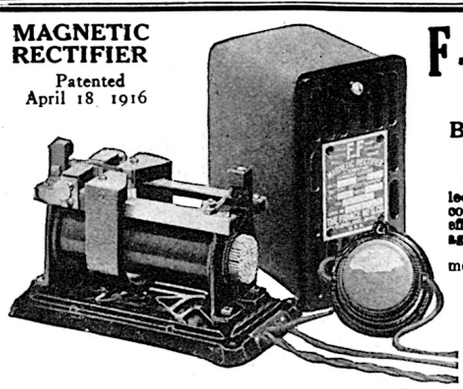

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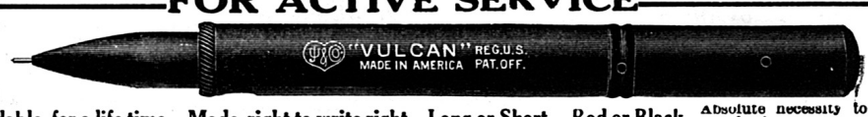

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touch each other, and should be slightly elevated from the bottom of the beaker, the anode being so placed that the spiral reaches slightly below the cone.

The electrodes are then connected to the battery, the platinum *cone* being connected to the negative terminal, and a current of 0.5 to 1 ampere past thru the solution. If the current from a dynamo or from storage batteries is used, it must be reduced to the requisite strength by introducing a system of resistance coils. If too strong a current is employed, the deposited copper is rough and less coherent. When only an occasional analysis is to be made, two or three Daniell cells may be used. In this case the zinc plate of the battery is negative and should be connected to the platinum *cone*. The copper is gradually deposited upon the platinum cone, and the blue color of the solution becomes fainter and fainter, until at last the liquid appears to be quite colorless. This operation necessitates several hours for its completion, and may be conveniently permitted to continue all night. To ascertain whether the precipitation is finished, one or two drops of the solution are withdrawn by means of a pipette, and a little hydrogen sulfid added, which should produce no coloration. The beaker is then lowered away without interruption of the current, the anode at the same time being disconnected and removed with the beaker. The cone is then dismounted and rinsed with water by means of a wash-bottle. It is then dipt once or twice into a beaker of alcohol, and placed in a steam oven for a few minutes to dry, and then weighed.

The gain in weight gives the copper in the amount of copper sulfate employed, from which the percentage of copper is thence calculated.

The electrolytic method is one that is much employed in the commercial analysis of valuation of copper ores and of metallic copper, as well as in the estimation of copper in alloys. The analysis is carried out in the following manner: 1. *In copper ores:* From 1 to 1½ grams of the finely powdered ore is weighed out into a porcelain dish, and treated with from 10 to 20 cc. of strong nitric acid. About an equal volume of dilute sulfuric acid is then added, and the mixture gently evaporated to about half its bulk in a covered dish. Water is then added, and the insoluble residue is filtered and washed. Copper ores frequently contain organic matter, in which case this residue will be dark colored, and is liable to retain a small portion of copper. If the quantity of bituminous matter is appreciable, it should be destroyed before treatment with nitric acid, by roasting the weighed quantity of powdered ore taken for the analysis in a porcelain crucible, with free access of air. The filtrat is diluted up to 200 cc. with water, 10 cc. of nitric acid added, and the solution electrolyzed as described above, with a current from two Daniell cells.

Experiment No. 120.

Estimation of Zinc.

About 2 grams of crystallized zinc sulfate are weighed out into a beaker, and dissolved in about 50 cc. of water. Six or seven grams of ammonium oxalat, dissolved in a small quantity of warm water, are gradually added, with constant stirring.

The solution is then diluted to 150 cc., and electrolyzed. The process is complete when a drop of the solution gives no precipitat when warmed with potassium *ferrocyanid* upon a watch glass. The platinum electrode containing the deposited zinc is then removed, thoroly rinsed with water, and finally with absolute alcohol. It is then placed for a few minutes in a steam-oven to dry, and then weighed.

Experiment No. 121.

Estimation of Nickel.

About 2 grams of ammonium nickel sulfat are weighed out into a beaker and dissolved in water, and the solution rendered strongly alkaline by the addition of ammonia. The volume of the liquid is made up to 150 cc. with water, and the solution then submitted to electrolysis. The process may be permitted to continue all night. It is complete when a drop of the liquid gives no precipitat with ammonium sulfid. The cathod is then washed and dried, and weighed as in the former estimation procedure.

Experiment No. 122.

Analysis of German Silver.

About 1 gram of the alloy is weighed out into a beaker, and dissolved in about 15 cc. of strong nitric acid mixed with the same volume of water. The solution is then diluted up to 150 cc. with water, and submitted to electrolysis. Under these circumstances copper alone is deposited. (It must be remembered that nitric acid is decomposed by the passage of an electric current, nitrogen peroxid and oxygen being evolved at the anod, while hydrogen is liberated at the negative electrode. This *nascent hydrogen* reacts upon the nitric acid, with the formation of ammonia. Hence if the current is allowed to continue passing thru the solution after the copper is all precipitated, the nitric acid is gradually decomposed in this manner, and then the zinc in the solution begins to deposit along with the copper.)

When the precipitation is complete (a drop of the solution, when tested by adding sodium bicarbonat and potassium *ferrocyanid,* should give no brown coloration of copper ferrocyanid) the beaker containing the solution should be lowered away from the electrods before the current is interrupted. The cathod with its deposit of copper is rinsed with water (the washing being added to the solution in the beaker), and finally dipt into alcohol and dried and weighed.

The positive electrod is also rinsed into the beaker, and the solution evaporated to dryness in a dish upon a water-bath, with the addition of a little hydrochloric acid, in order to convert the remaining metals into chlorids.

The residue is dissolved in water and a few drops of hydrochloric acid, and the solution transferred to a beaker. Sodium carbonat solution is added until a slight precipitat persists, after which hydrochloric acid is added, drop by drop, until the precipitat just redissolves. The zinc is then precipitated from this solution as zinc sulfid by means of ammonium sulfid. The washed precipitat is dissolved in the smallest possible quantity of strong hydrochloric acid, and the solution evaporated to expel the excess of acid. The residue is dissolved in water, ammonium oxalat is added as described in Experiment No. 120 (Estimation of Zinc), and the solution diluted with water to 100 cc. and electrolyzed.

The filtrat and washings from the zinc sulfid contain the nickel, which may be precipitated either from the double ammonium sulfat or oxalat. *From the double sulfat:* Three or four grams of ammonium sulfat dissolved in 10 cc. of water are added to the solution, and then about 20 cc. of strong ammonia. The mixture is diluted with water to 100 cc. and electrolyzed. *From the double oxalat:* Four or five grams of ammonium oxalat, dissolved in about 20 cc. of warm water, are added to the solution, which is then diluted with water to 100 cc. and electrolyzed, the liquid being maintained at a temperature of about 40 to 50 degrees thruout the operation.

Alloys consisting of copper and nickel only may be analyzed electrolytically in the following manner: From 0.5 to 7.5 gram of the alloy is dissolved in the minimum quantity of nitric acid (diluted as above), and the solution evaporated to dryness with the addition of a few drops of sulfuric acid. The residue is taken up with water, and again evaporated to dryness with a few drops of sulfuric acid to completely expel the nitric acid. The residue is dissolved in water with a few drops of sulfuric acid, and made up to about 100 cc., and the solution electrolyzed by employing a current of 0.5 ampere for from 4 to 6 hours. The electrod is washed and dried and weighed as previously described. To the solution 15 cc. of strong ammonia are added, and the liquid electrolyzed with a current of about 0.3 ampere (or 3 Daniell cells). The nickel will be entirely deposited in about six hours.

Hydrolysis.

Certain salts mixed with water react to some extent with it. Salts of antimony, bismuth, arsenic, tin, etc., are examples, as $SbCl_3 + H_2O = SbOCl + 2H + 2Cl$. SbOCl is precipitated, the solution being slightly acid on account of the presence of hydrogen ions. The stages in the reaction of $SbCl_3$ and H_2O may be as follows:

$$SbCl_3 + 3\,H_2O = Sb(OH)_3 + 3\overset{+}{H} + 3\overset{-}{Cl}$$

$$Sb(OH)_3 + 3\overset{+}{H} + 3\overset{-}{Cl} = SbOCl + 2HCl + 2H_2O$$

Thus in the first equation a base, together with acid ions, is present in the mixture, and that constitutes a case of hydrolysis. The acid is shown in the second equation.

Hydrolysis is the action of water on certain salts to break them up into acids and bases.

Hydrolysis should be carefully distinguished from ionization.

(To be continued)

"ELECTRO-MAGNETIC LOG" THAT MEASURES SHIP'S SPEED.

(Continued from page 817)

device may be used a long time before the zinc sulfat has to be renewed. Amalgamated zinc, surrounded by the zinc sulfat, forms a non-polarized electrode even tho the chemicals used may be somewhat impure, the zinc sulfat forming a concentrated solution around the metallic zinc.

The magnet is so located that the movement of the magnet thru the water takes place in a direction parallel to the plane of the two plates. The lines of magnetic flux, as shown in Fig. 4, pass from the middle pole N to the side poles S forming a magnetic field which is moved thru the water in a direction *perpendicular* to the plane of the paper, the magnetic field

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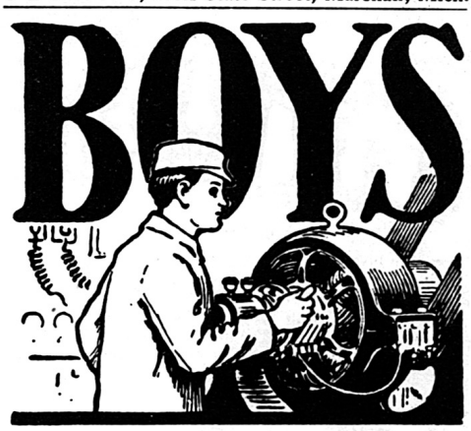

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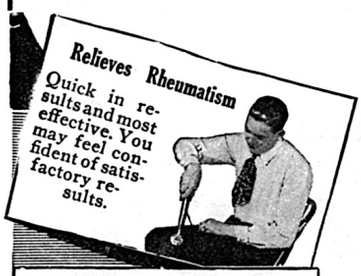

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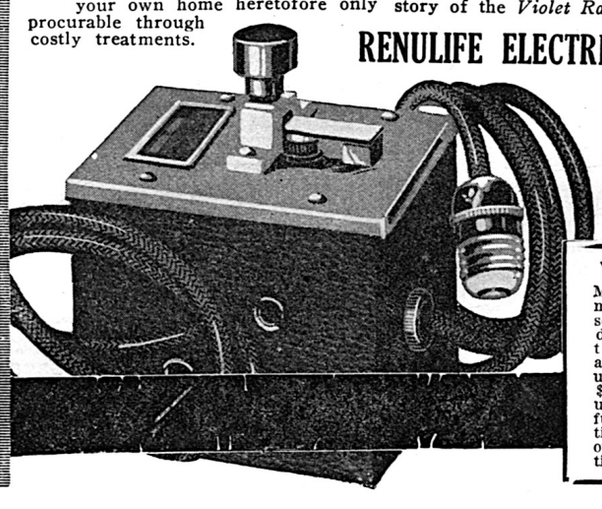

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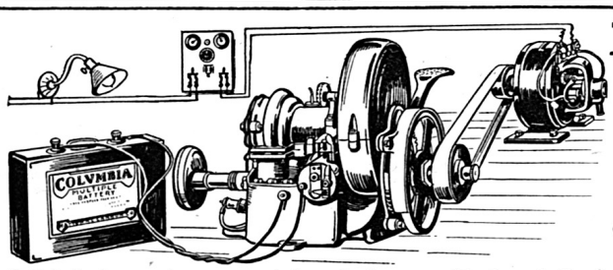

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being *transverse* to the direction of movement of the magnet. The movement of this magnetic field causes a difference of potential between the electrode points in the water at the surfaces of the two earthenware windows, the direction of the electromotive force being indicated by the dotted lines. Since the windows are porous and conducting, and the electrodes are carried along with the magnet, the electrodes should be maintained at substantially the same potential as the points, provided the electrical resistance thru the porous windows between the electrodes is small or the current flowing between the electrodes is small or zero.

In order to measure the difference of electric potential induced between the two points, the two electrodes are connected by a cable to a low resistance coil as shown. A battery maintains a direct current thru the resistance when readings are to be taken, a switch being provided on the indicator panel (on the ship's bridge or in the pilot's cabin) for the purpose of opening and closing this circuit. An ammeter, calibrated to read *knots per hour* directly, and an adjustable resistance are connected in the battery circuit, as the diagram shows. The resistance regulator is moved until the potential drop across the low resistance coil just balances the voltage induced between the two electrodes by the movement of the magnetic field thru the water. A zero instrument (galvanometer) is connected in one of the leads as shown, and the resistance coil is adjusted until the galvanometer shows no current passing between the hydro-electrods.

The value of the resistance being known, then by reading the ammeter the potential drop across it can be computed; this potential drop is equal to the E. M. F. induced between the hydro-electrods, by the movement of the magnetic field thru the water. When the magnetic strength of field is known, the induced E. M. F. for different speeds of ships may be computed or determined experimentally, and the ammeter calibrated to read the speed of the ship in miles or knots per hour, as aforementioned.

By using the zero method, the effect of variations in the resistance of the water and the porous windows between the hydro-electrods is eliminated as a source of error.

The operation of this log device is based upon sound electro-dynamic theory and the inventors have worked out the mathematical analysis for it. These are too technical for consideration here, but in general it may be said that the theoretical action is as follows:

If a magnetic field moves thru a medium, electro-motive forces are induced in that medium, the intensity of which per unit volume is proportional to the product of the velocity of the field by the component of the magnetic force perpendicular to the direction of motion of the field, and the direction of which E. M. F. is perpendicular to the direction of motion of the field and to the lines of force of the field. In other words, we have here to deal with a three-dimensional conducting medium under a steady state of current flow caused by a volume distribution of electro-motive forces.

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POWER WIRING DIAGRAMS, by A. T. Dover. 208 pages; size, 4¼ x 6¾ inches; 254 illustrations; semi-flexible covers, pocket size. The MacMillan Co., New York, American publishers, 1917. Price, $2.25.

A handy pocket-size edition, which should prove of practical service to electricians, especially those who come in contact with the application of motor power to industrial plants.

It contains a very large number of diagrams of standardized apparatus and machinery, and so far as possible actual control apparatus has been kept in mind in laying out the various circuits.

The following list of chapters should prove of interest: Continuous-Current Motors and Control Apparatus, Continuous-Current Generators and Balancers, Continuous-Current Switch Panels, Control Apparatus for Alternating Current Motors, Power Transformers, Instruments, Instrument Transformers and Relays, Leakage Protective Systems for Continuous-Current and Alternating-Current Circuits, Alternating-Current Switch-Gear and Automatic Voltage Regulators.

A large and comprehensive appendix is also included which contains numerous charts, curves, tables and miscellaneous data of practical value.

A very practical work, and altho a large amount of the text deals with foreign types of apparatus and applications, the various ideas and theories will be found of value to American electricians and engineers.

HOW TO MAKE HIGH PRESSURE TRANSFORMERS, by Prof F. E. Austin. Second edition, 46 pages; illustrated; size, 4⅝ x 7⅛ inches; stiff covers. Publisht by the author at Hanover, N. H., 1917. Price, 65 cents.

A timely work of unusual interest to amateurs and experimenters especially, that just fits the pocket, as well as the amateur's pocket-book. A wealth of information is included in a very small space pertaining to transformers, from the theory to actual constructional work. The first chapter defines the function of a transformer and gives tables and rules for computing various sizes of transformers with pointers which safeguard the occurrence of errors usually found in home-made apparatus.

The closing chapter gives complete directions for building transformers of the following sizes: 1 K.W., 20,000 volts; 3 K.W., 20,000 volts, and 1 K.W., 4,000 volts.

The above are secondary voltages. All three designs are intended to operate on 110 volts, 60 cycles A. C.

A useful table giving data on copper magnet wire is included and a complete list of parts necessary for the construction of each transformer, with prices, and it might be said that these prices are of course rather out with current fluctuations of quotations and cannot therefore be followed.

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(*Continued from page* 815)

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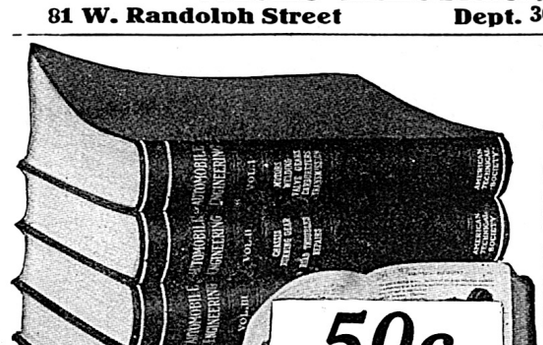

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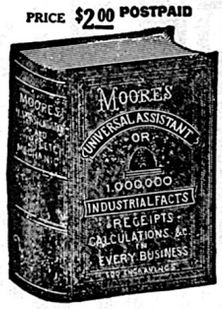

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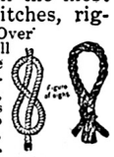

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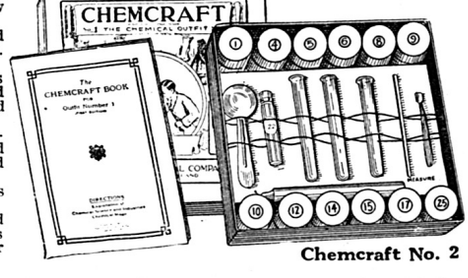

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ranged upon opposite sides of the hull under the mirrors, the searchlights being mounted to project light diagonally upward and toward the respective mirrors on opposite sides of the vessel. The searchlights may be slightly offset from each other, so that the rays of light projected from the two searchlights will not intersect and interfere with each other, and the mirrors serve to throw the rays of light downwardly thru the respective transparent plates fitted in the bottom of the hull.

A submerged submarine would ordinarily be easily located by these downwardly projected rays of light, *and a torpedo discharged vertically downwardly at a time when the vessel is directly over the submarine, would result in a speedy destruction of the submarine.*

A seat for the operator is shown as arranged just back of the transparent plates, and suitable levers are provided for manipulating the mirrors to position them in a proper manner for reflecting the light in the desired direction. (It should be noted that the operator manipulating the underwater search-lights could not himself "spot the submarines. It is a well-known fact that the observers on a battleship are stationed quite a distance away from the search-light. This could be arranged here by flashing alternate beams, observing thru the dark windows.)

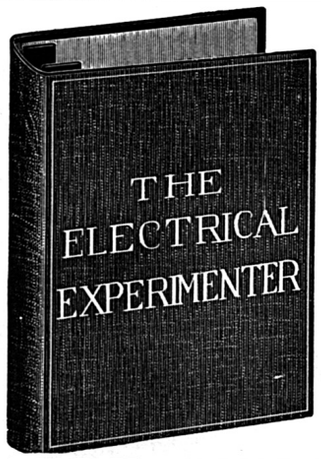
A SYNCHRONOUS MOTOR MADE FROM AN IRON PULLEY.

(*Continued from page* 843)

platinum wire are allowed to protrude thru holes in the bottom of the pan and sealed in with paraffin or beeswax. The sides and bottom of the pan are coated with melted paraffin. The pan and two test tubes are filled with acidulated water (electrolyte) and while under the water the tubes are inverted and placed over the platinum wires. The tubes should be previously graduated by weighing twice as much pure water in one as in the other. The level of the water is then marked on each tube with a little oil paint or scratched with a file.

It is possible to rectify both waves of the alternating current by equipping the shaft with two slip rings besides the commutator as shown in the diagram, Fig. 3, altho it complicates matters considerably. In this case the brush bearing directly on the shaft would be dispensed with, but there would be two brushes bearing on the commutator and a brush for each of the two slip rings.

All of the shaded sections are directly connected to the inner ring in diagram, and the clear segments to the larger ring shown. The commutator must revolve at such a speed that during each half cycle a section passes under each brush; and the brushes must be so set that both of them change connections at about the same time. The adjustment should also be such that the change from one section to the other is made at the time when the current wave is passing thru zero. The connections being properly made, the rectified current will be a pulsating current, all of the pulsations in the rectified side of the circuit being in one direction, as indicated by diagram, Fig. 3. Many other interesting and extremely instructive experiments can be conducted with this little synchronous motor. Books dealing with the subject in a clear manner are the following: "Alternating Currents Simplified," by Elmer E. Burns; "Alternating Current, Theory, Practise and Diagrams," by Horstman and Tousley. More advanced students who may be interested in rotary converter actions, etc., will find these problems ably dealt with in "Alternating Current Electricity," in two parts, by Timbie and Higbie.



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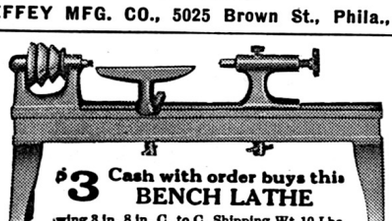

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THE CHEMISTRY OF SELENIUM.

(*Continued from page* 845)

tion which now contains Selenic acid (H_2SeO_4), is obtained and when cold, diluted with water, filtered, and then heated with a quarter of its volume of fuming hydrochloric acid, until three-quarters of the liquid has evaporated. By this process, chlorin is evolved, and is reduced to Selenious acid (H_2SeO_3). The cold solution is then poured off from the sediment and saturated with sulfur dioxid, when selenium separates out as a red powder.

(1) $HgSeO + 3SO_2 + 2H_2O = 3H_2SO_4 + Se$

Selenium may also be prepared by digesting the lead-chamber deposit on a water-bath with a concentrated solution of potassium cyanid until it assumes a pure gray color:

(2) $KCN + Se = SeKCN$

From this solution the selenium is deposited in red-flakes, on the addition of hydrochloric acid. This deposit contains both lead and copper, and these impurities are removed by distillation or by being fused with a mixture of Niter (Potassium Nitrat) and Sodium Carbonat, and this is again treated with hydrochloric acid and sulfur dioxid. These impurities may be removed by evaporating the selenium to dryness with nitric acid, and reducing the aqueous solution of selenious acid by means of sulfur dioxid.

Properties:

Selenium, like sulfur with which it is isomorphous, exists in three different allotropic forms, three well defined forms being known.

1. Amorphous, Vitreous, and Colloidal selenium, being slightly soluble in carbon disulfid. These three differ in appearance but may all be considered as belonging to the same allotropic modification, and are sometimes known as "liquid" selenium.

(a) Amorphous: This modification is formed as a finely divided brick-red powder. when a solution of selenious acid is precipitated by sulfur dioxid gas, or when the acid is reduced by Zinc, Stannous (Tin) Chlorid, or other reducing agents, and is also formed by the electrolysis of the acid.

This form is slightly soluble in carbon disulfid, which produces a change to dark gray metallic selenium at about 97 degrees. This form has a specific gravity of 4.26.

Amorphous selenium is often obtained in a colloidal form, which is very unstable, and will not keep, and which is soluble in water. This colloidal modification is formed when a solution of sulful dioxid is added to a solution of selenious acid, and when a diluted solution of the acid is reduced by

(*Continued on page* 870)

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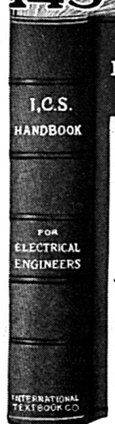

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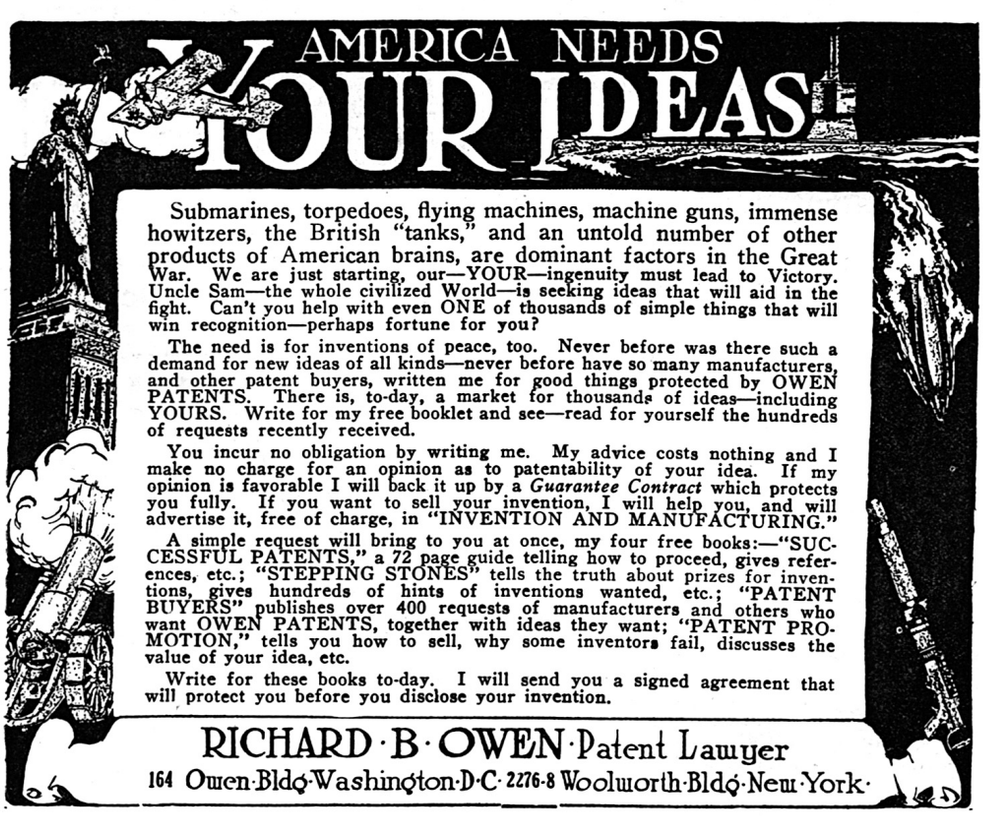

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In this Department we publish such matter as those who are in doubt as to certain Patent Advice" cannot be answered by mail free of benefit of all readers. If the idea is thought to divulge details, in order to protect the inventor

Should advice be desired by mail a nominal Sketches and descriptions must be clear and ex ten on.

ELECTRIC PARACHUTE.

(209) Loyd Nord, International Falls, Minn., has sent in an idea whereby a parachute is to be installed on an aeroplane in such a manner that when the pilot becomes endangered, all he has to do is to press a button on the steering wheel which will immediately explode a cartridge by means of certain electrical firing apparatus, which in turn will shoot up a parachute which is attached to the seat on which the pilot remains. This is supposed to disengage from the aeroplane and land the operator in safety.

A. This is an idea that looks very well on paper, but is not practical for the reason that the exploding cartridge would certainly tear the parachute to pieces. Parachutes have been tried on aeroplanes before, but have not met with much success. We do not think that an invention of this kind would be practical.

"BELL SOFTENER."

(210) W. B. Hanlon, Pittsburgh, Pa., has submitted a *bell softener* which comprises a number of brass tubes which are to be struck by a certain re-arranged form of clapper on a bell. This is supposed to do away with the harsh sound. Our advice is asked.

A. A device of this kind does not fall within our idea of a *bell softener.* Quite the contrary, we are certain that it will make the sound just as harsh as if an ordinary gong were used. We are afraid this does not solve the problem of *softening* the noises of an ordinary telephone bell.

COLLAPSIBLE TYPEWRITER.

(211) Harry Drake, Seattle, Wash., writes as follows:

"Could you give me information concerning the possibilities of inventing a collapsible typewriter, weighing only a few pounds and suitable for school use?"

A. The possibilities of this device are, of course, very good, and there should be a vast field for such a machine, if it can be built cheap enough, and if the machine is mechanically right. There are several collapsible machines on the market now, as for instance the "Corona" machine, but this is rather expensive.

CARDBOARD MOUSE TRAP.

(212) A. R. Dunham, New York City, has sent in a clever design and description of a cardboard mouse trap which can be made and sold for less than 10c if necessary. The idea being that once a mouse is in the cardboard box, it can be disposed of with its contents. The thoughtful inventor has even provided the box with a string, and the box is arranged in such a manner that it will not come open of its own accord. These features should prove especially attractive to the "weaker sex."

A. This idea is a very good one. It seems to have commercial possibilities, if worked out right. We would advise our

ADVICE

H. GERNSBACK.

is of interest to inventors and particularly to Phases. Regular inquiries addrest to "Patent charge. Such inquiries are publisht here for the be of importance, we make it a rule not to as far as it is possible to do so.
charge of $1.00 is made for each question. plicit. Only one side of sheet should be writ-

correspondent to try out a few of these traps in actual practise to see if the mice are not afraid of the contraption, as these rodents are, as a rule, very wily and fear traps of this kind. We believe a patent can be obtained on this device.

SPECIAL FLASHLIGHT.

(213) Thomas A. Pilling, Camp Greene, Charlotte, N. C., submits a design of a flashlight having a special spiral filament bulb and conical concentrator for the rays. The flashlight is supposed to be used by physicians and dentists for exploration of small cavities.

A. A device of this kind is not new. Similar instruments of this sort are being marketed right now. We do not think a patent could be obtained on a device of this kind.

COMPREST AIR SHELL.

(214) F. M. Keesling, New Albany, Ind., has submitted an explosive shell for war purposes in which air, comprest to a very high degree, is used instead of an explosive. The shell is afterwards exploded in a certain manner.

A. We fail to see anything practical in a device of this kind for the reason that the entire arrangement is too complicated, too costly, as well as too cumbersome to handle. We also believe it is somewhat dangerous, as our correspondent proposes to charge the shell with a comprest air up to almost the bursting resistance of the shell itself. We think that the present explosive shell containing ordinary explosives is very much more satisfactory in all respects, being vastly cheaper to manufacture, and having quite a number of other advantages over the comprest air type.

AUTO FASTENER.

(215) Chas. Buerger, Cheboygan, Mich., has asked our advice on a certain fastener for automobile work which contains certain threads, and which for this reason will not loosen up, he claims, due to the vibration of the car.

A. We think that the ordinary snap fastener is altogether more desirable, as threads always work loose when used in an automobile due to vibration, which is well known. We do not encourage the idea.

OIL ATTACHMENT.

(216) Fred Van Dyke, Detroit, Mich., wishes to know if a device whereby a certain oiling device is attached to stock and dies is new, and whether it can be patented. The idea is that every stock and die needs a good deal of oil, which at the present time is supplied by hand, by means of an oil can. Our correspondent does away with this feature, using an automatic oiling arrangement incorporated in the tool itself.

A. This is a very clear idea, and quite novel as far as we can see. We have never seen the like of it, and would advise him to get in touch with a patent attorney.

Mr. E. Hume Talbert

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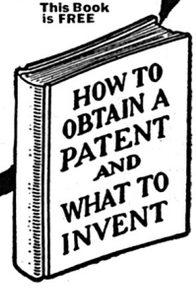

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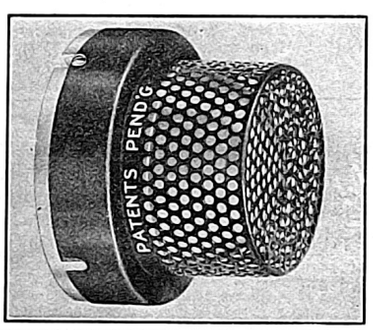

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THE CHEMISTRY OF SELENIUM.

(*Continued from page* 867)

hydrazin hydrat. It can also be prepared by pouring a solution of selenium in carbon disulfid into a large volume of ether, according to Maljisheff. It is a dark red powder which is completely soluble in water, forming a red fluorescent solution, which gradually becomes insoluble on preservation. The solution may be boiled without undergoing any change, but the selenium is deposited on the addition of acids or salts. The solution on spontaneous evaporation deposits the selenium as a red transparent film.

(b) Vitreous: Vitreous selenium is always produced when liquid selenium has been heated to 217 degrees and rapidly cooled. It then solidfies to a dark brownish-black, glassy, amorphous, brittle mass, which is also slightly soluble in carbon disulfid. This form has a specific gravity of 4.28. These varieties have no definite melting point, softening gradually on heating. Like the ordinary amorphous selenium, Vitreous selenium does not conduct electricity.

(c) Insoluble or Metallic Selenium: This modification is obtained by cooling melted selenium quickly to 210 degrees, and then keeping the melted mass at this temperature for some time. The selenium at length solidifies to a granular crystalline mass, the temperature rising suddenly in the act of solidfication to 217 degrees. This change from the amorphous to the metallic condition also takes place, only more slowly at lower temperatures; thus if a mass of amorphous or vitreous selenium be gradually heated it softens and then as soon as the temperature approaches 100 degrees, begins to pass rapidly into the metallic form, the temperature rising to 217 degrees. A similar change occurs at the ordinary temperature when amorphous selenium is placed in contact with quinolin, anilin and certain other liquids in which it is soluble, or by fusing the vitreous form between carbon plates and then allowing to cool slowly. If a concentrated solution of potassium or sodium selenid be exposed to the air, metallic selenium separates out in microscopic crystals, and it is also formed as a crystallin powder when sulfur dioxid is past thru a hot solution of selenious acid, the amorphous form, which is the first product, being rapidly converted to the metallic variety.

Metallic selenium conducts electricity and *exposure to light increases its conducting power.* The peculiar effect to light is best exhibited on selenium which has been exposed for a considerable time to a temperature of 210 degrees, until it has attained a granular crystalline condition. When selenium in this condition is heated, its electrical resistance is increased, whilst on exposing it to the action of diffused daylight, the electrical resistance instantly diminishes; this however, is only a temporary change, for on cutting off the light, the electrical resistance of the selenium slowly increases, and after a short time reaches the amount exhibited before the exposure.

Metallic selenium possesses all the physical characteristics of a metal. In the making of selenium cells the selenium must be in a metallic condition. Vitreous selenium which has *not been annealed,* when used in cell making is useless, due to the vitreous modification being a *perfect non-conductor.* The peculiar sensitiveness of selenium to the electric current, when exposed to light, is attributed to its metallic modification, caused by *annealing.*

Methods of making Selenium Cells:

Various methods of making selenium cells have been described in previous issues of this journal (ELECTRICAL EXPERIMENTER,

July, 1913, p. 39; September, 1916, p. 339; September, 1917, p. 325;) and for experimenters who desire to make cells along these lines, no further comment need be made.

It should be remembered in constructing these cells, that it is imperative that certain conditions be fulfilled in order that the completed cell be satisfactory for the work for which it is designed.

The first condition is, of course, the purity of the selenium used. Marc has observed that impure selenium crystallizes less completely in a given time than pure selenium.

As regards the insulator upon which the wire electrodes are wound, many experimenters advocate the use of porcelain, glass, and mica, the latter being probably the most satisfactory of these, for the work intended, due to the fact that it will withstand high temperatures without being ruptured. Porcelain and glass on the other hand can not be worked into various forms except with difficulty.

Thus we see that a substance is to be used which possesses all these desired properties —namely, that it is a good insulator, will withstand the heat required, and at the same time be sufficiently soft to permit more easily being handled and machined.

Again, most experimenters are using copper wire as electrodes, but the drawback to copper wire lies in the fact that at the temperature required for annealing, a film of copper selenid is formed, which covers the wire. This also materially increases the resistance of the cell, and is therefore undesirable for use as electrodes. Platinum wire is of course the ideal wire for this purpose, but due to the extreme high cost, is beyond the reach of the average experimenter. Therefore a different kind of wire must be utilized for the electrodes, one which will not oxidize at the temperature of annealing.

The present form of application of the selenium to the electrodes and insulator is also unsatisfactory, in that, when the selenium changes to the metallic variety on solidification, unless handled with utmost care (which as a rule is difficult for beginners), an uneven application is obtained instead of a *smooth, thin film,* which naturally does not prove satisfactory. Therefore a method of applying the selenium must be found, one which will deposit it in a thin, smooth film, in place of the lumpy mass which is frequently obtained by the present method.

The writer has been conducting extensive experiments along original lines for the preparation of cells which may prove more reliable than those made at present, and in the near future hopes that he will be in a position whereby he can present a paper describing his results.

Tests for Selenium:

If the substance to be tested is a solid, dissolve it in water (about 10 to 15 cc.), by either crushing or heating the liquid. If a liquid, dilute with distilled water. Shake the mixture thoroly, by placing the thumb over the mouth of the test tube and shaking the contents vigorously. Add 10 cc. of Hydrochloric acid, and then introduce a small piece of tin or tin-foil (1 in. x ½ in.) into the mixture.

A freshly prepared solution of stannous (tin) chlorid may be added to the suspected solution in place of the hydrochloric acid and tin above mentioned.

After a few moments, if selenium is present, a light pink tint to blood-red discoloration will be visible around the surface of the tin, depending upon the amount of selenium present.

This test extracts all of the selenium present, therefore it is also a quantitative as well as qualitative test. It is very sensitive, being capable of detecting such a minute trace as 3/100,000 milligram of selenium if present.

Uses of Selenium:

So much has been said in previous issues of this journal regarding the uses of selenium as well as the application, that the writer will not go over the same ground as covered in these articles.

In 1873 Willoughby Smith noted that the electrical conductivity of selenium varied with light, the metal being about *500 times* as good a conductor under the influence of light as in the dark. This opened a very extensive field for research work among the investigators who were conducting experiments with this substance, and the numerous appliances developed by scientists have been covered in previous papers. The application of the electrical properties of selenium are still in the experimental stage and the future will undoubtedly reveal new apparatus which will depend principally upon these remarkable electrical properties.

Selenium has been used in the glass industry. In 1891 Wetz patented the use of selenium for producing red or orange stain in glass and in 1894 Spitzer employed selenites and selenates, in conjunction with a reducing agent, to color glass. Since then selenium has been used to produce red colored glass, particularly ruby glass, where the red must be clear, without a trace of green, as in railroad signal lights, and photographic dark-room lamps.

Various shades of glass may be obtained by combining selenium with gold and silver, and with opacifying metals, oxides and minerals, such as cryolit, fluorspar, etc. Selenium is also used as a decolorizer in white glass for discharging the green color due to iron.

Wasserman has patented a process for making dyestuff, by using salts of selenium in conjunction with organic salts.

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Due to the congestion existing at the present time in all railroad movements, also on account of the fact that many train clerks have gone to war, there is a congestion of mails all over the United States. It may happen that your magazine will be slow in reaching you, and this delay may be from a few days up to several weeks.

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AT WAR WITH THE INVISIBLE.

(*Continued from page* 819)

cil, in solemn conclave assembled. listened with deep-breathing silence while I partly read, partly related, certain phases of my chance discovery and Firman's part in the great secret. Ingals, whose power as the keenest editorial mind in that great city was so well recognized that he had been selected as chairman of the advisory board, sat at the far end of the long, ebony table, his features twitching with a strong, inner excitement held in abeyance. His head nodded in tigerish acquiescence as I dramatically wound up with Firman's final words of advice to the council. I sat down quickly, my own heart beating discordantly as the vast import of the whole situation came back to me in an overwhelming surge.

There was silence for one brief moment. Then a deep murmur of voices arose. The

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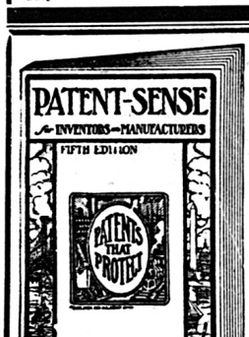

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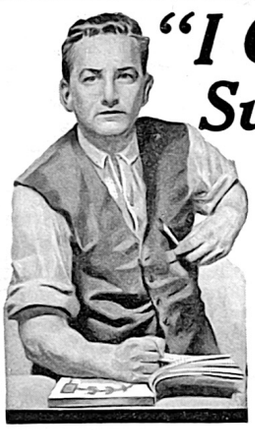

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next instant I saw Ingals rising from his seat without the formality of a request to the Council Chair.

"I move this body accept in its entirety the report of Mr. Elvan," he shot out in sharp, decisive voice, "and that we adopt unqualifiedly Professor Firman's suggestion, abiding decidedly in that scientist's ability to direct our next move!"

The positive ring of his tone imposed itself upon the overwrought nerves of us all. There was no time to reflect and deliberate. The surcharged air of the meeting seemed to have exploded with the lightning decision of Ingal's action. In sheer relief, it seemed to me, a sonorous voice somewhere in that august body rumbled out. "I second the motion!" and the next instant the council had accepted the die and cast it like a challenge in the face of the demon forces.

By Monday morning a startled universe heard aghast, and with mingled feelings of fear and hope, that the Martian insolence was to be defied, and that secret preparations were being perfected with all haste under the direction of a leading scientist.

Thursday noon was the time when the Martian ultimatum was to expire. Since 1 o'clock in the morning of that fateful day the laboratory in the university on Morningside Heights, now converted into a pulsating workshop, had been the scene of tremendous activities. Two by two, a thousand planes had stopt at Firman's windows, around which a screened landing platform had been erected, and received aboard sealed cases of materials and trained operators. As rapidly as they were equipt they departed to their assigned stations. By 10 o'clock the last pair of planes was at the platform. We piled the remaining cases aboard and climbed into one of the machines.

Ava was with me. She had insisted on coming and I had no desire to refuse her. Either we were to be successful, and my joy in the triumph would be heightened by sharing it with her, or we would fail, and then we could perish together in the midst of the cataclysm.

It was an hour pregnant with fatal possibilities, and our faces showed the strain. Even Firman, with his nerves of steel, reflected the general feeling. His eyes were sunk deep in their sockets and his prominent nose was still further accentuated by the hollows in his cheeks.

The scheme he had perfected was gigantic in its simplicity. The planes were stationed in pairs at equal distances above New York. On each plane was a sending and receiving station (tuned to the same wave-length as that of its mate) for a powerful helium ray. The two rays, crossing in the electrical field generated between the planes, reflected the images in their paths on sensitive selenoid plates within the planes. Thus, by covering the entire territory, we would discover the Martians when they landed to plant their contact points, *if Firman's plan did not miscarry.*

Eleven o'clock was the hour when Firman expected the invaders would begin their work in order to fulfill the threat of their ultimatum. Precisely on the second he flashed the order to the sentinel planes to open their batteries.

Our machine was stationed with its mate over Battery Park. As the order was given, and the powerful ray shot out of the crackling batteries, we bent over the selenoid plate with passionate eagerness. Ava's hand was in mine, our fingers intermingled in a clasp that drove every atom of blood from them. Our breaths came and went in short, agitated gasps. I stole a glance at Firman. His eyes were gleaming with deep intensity as he watched every tremor on the sensitive surface.

The area of our electric field included all of Battery Park and the greater part of the bay. The helium rays swept back and forth and ghostly outlines of ships passing thru the harbor and people walking in the park appeared on our plate. For ten minutes we kept our silent vigil, then suddenly our hearts leaped and a rush of blood to my head almost obscured my vision. *Two long, elliptical objects had dropt from the sky and were landing on the grass, a short distance from the water front!*

We would see distinctly every movement of the Martians inside their marvelous planes. The faithful ray penetrated every corner of the craft and pictured the details in spectral outline on the selenoid plate. We even saw the skeletons of the men thru their coverings of flesh, and it seemed as if some hideous creatures from the nether world had come to wreak unholy devastation upon us.

Firman stiffened, a haggard smile of triumph on his sharpened features. An instant longer he watched those phantom figures moving about boldly, confidence in their shield of invisibility making them utterly devoid of caution. Then I saw Firman's eyes crinkle with deliberate grimness, saw him motion to the gunner at his side, and saw the latter adjust his weapon to the range indicated by the finder on the selenoid. His fingers worked deftly, coolly. He nodded to the scientist.

With an audible sigh of satisfaction Firman uttered the word: "Fire!"

A deafening crash shook our plane. From somewhere below came the sound of splintering glass and metal, coupled with shrieks of agony. The crawling image on my plate broke, rose into a thousand fragments and fell in deathly silence. As in a nightmare I heard the next command: "Now the other!"

Again the long, slim gun whipt out its tongue of shooting flame, and from the ground the din of destruction rose in clamoring echo. The invisible fleet lay, a futile ruin, on the soil of the city it had come to destroy.

As those rising from the tortured dreams of a black night, we stared at each other, unable to speak in the first few moments of indescribable relief. Then Ava burst into tears and I took her in my arms.

"The Universe is saved!" I cried in an ecstasy of joy.

"Yes," agreed Firman; then added thoughtfully: "And the Martians take their place in that long blacklist of fools who would conquer the world by force!"

(THE END.)

COSMIC FORCE.

(*Continued from page* 829)

liberated, as with combustion in the form of heat. These crystalized specks of energy may be made up of complex vibrations that have either a positive or negative charge and cling together not only from their own inherent vibratory form but also by the action transmitted from the sun. One form of energy made up in a certain complex form would have its own characteristics, as copper might have ions like Fig. 1, and iron with ions as in Fig. 2, etc. This probably explains why different materials take a definite crystaline form, which is one of the principles on which metallurgy is based.

These specks of energy make up molecules that are in a fixt state and by means of chemistry and metallurgy we are able to disassociate the different classes of molecules by means of their characteristics. These sciences have been developed so that we can now understand a great many of

the characteristics of the energy about us and with which we have to deal, but the greatest understanding and enlightenment will come to us when we delve more deeply into the causes which produce all the conditions about us, that is, what is this universe in which we live and what perpetuates its existence?

ELECTRICITY TO PREVENT FUTURE FUEL CRISIS.

(*Continued from page* 825)

were supplied from one big generator. At first sight it would appear that a 40,000 H.P. machine would be needed to carry the load, but such is not the case. As a matter of fact a generator of *30,000 H. P., or even smaller,* would be ample, for the simple reason that all the industries would never need their full quota of power at the same time. The principle is the same as that which permits a bank to serve its depositors with a cash reserve that is very much less than its total deposits. When producing its own power each plant might occasionally need the full power of its generator, but for the most part the generator would be running below its rated capacity and therefore under conditions of poor economy and high coal consumption per horse-power. By combining all these small loads on to one machine, a much more uniform large load and a much higher operating efficiency are obtained. As a result, the large unit would consume *even less than from ½ to ¼ of the coal* consumed by the individual plants of the 80 industries.

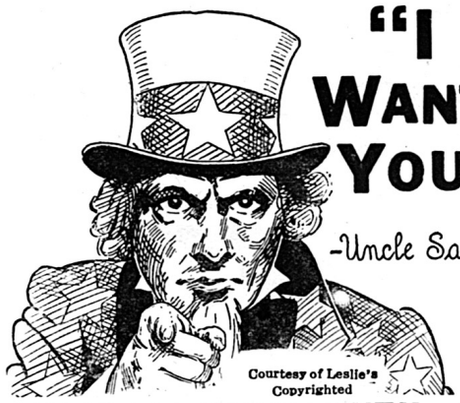
The same principle applies to cities as well as to plants, and if, therefore, several cities were supplied with power from a single system (obtaining its electrical energy from several large steam and water-power generating stations), the saving in fuel as compared with present conditions would be truly remarkable.

Small generators must necessarily be near their loads and the coal they need hauled to them. This, however, is not the case with large machines generating enormous amounts of power and capable of supplying the demands of entire cites. It is thoroly feasible to place the generator at the mine and transmit the electric energy over wires, thus eliminating railroad transportation altogether. The bee-line distance between New York City and the anthracite regions is but 100 miles. Electricity is at this time being transmitted over 200 miles in several American systems, and in one case the distance is over 400 miles. How gratifying it would be at this time if New York's power were independent of railroads and tug-boats!

But where central generating stations had to be located away from the mines, as in many cases it will still be necessary for some time to come, it would obviously be a very much simpler matter to supply with coal a few large plants equipt with every modern time- and labor-saving device than to distribute coal to a large number of small plants situated in all sorts of inconvenient locations and without proper facilities for rapid handling of the fuel. Much of our present trouble is due to the difficulties incident to rehandling the coal-waiting cars, frozen coal, an insufficient number of trucks, teams, and men, etc. Such difficulties would be entirely eliminated were the bulk of the coal to go to a few central points.

Passing now to the fifth point, the electrification of a large portion of our railroad system (no one expects that all of our railroad mileage will be operated electrically during the present century) would be the greatest single step that can be taken in the direction of fuel economy. *American railroads consume nearly 150,000,000 tons of coal annually, nearly one-quarter of our entire output.* Much of this coal consumption could be eliminated by the use of water-power, and almost as much could be saved by generating power in efficient, steam-operated, central station plants, instead of in the naturally wasteful steam locomotives. Some idea of the possibilities can be obtained from the fact that the Chicago, Milwaukee and St. Paul Railroad *saves* annually *a half a million tons of coal and several hundred thousand barrels of fuel oil* by operating 440 miles of its line by means of hydro-electric power.

Equally important, from the stand-point of preventing a recurrence of the present fuel crisis, would be the great increase in traffic capacity that electrification would secure for our railroads. The steam locomotive has about reached the limit of its power and therefore freight trains have also about reached the limits of their length and speed. But with electrical operation of the railroads there is practically no limit to the amount of power that can be applied to a single train. Electric locomotives *several times more powerful* than the largest steam locomotives are already in operation, and still larger ones can be built when occasion demands. With more power available longer trains could be operated at higher speeds, which means that more freight could be hauled in a given time over existing rails.



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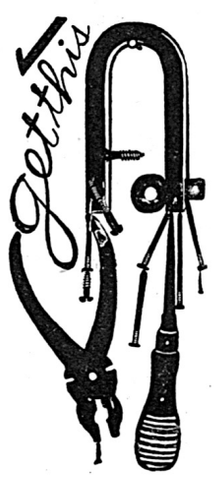

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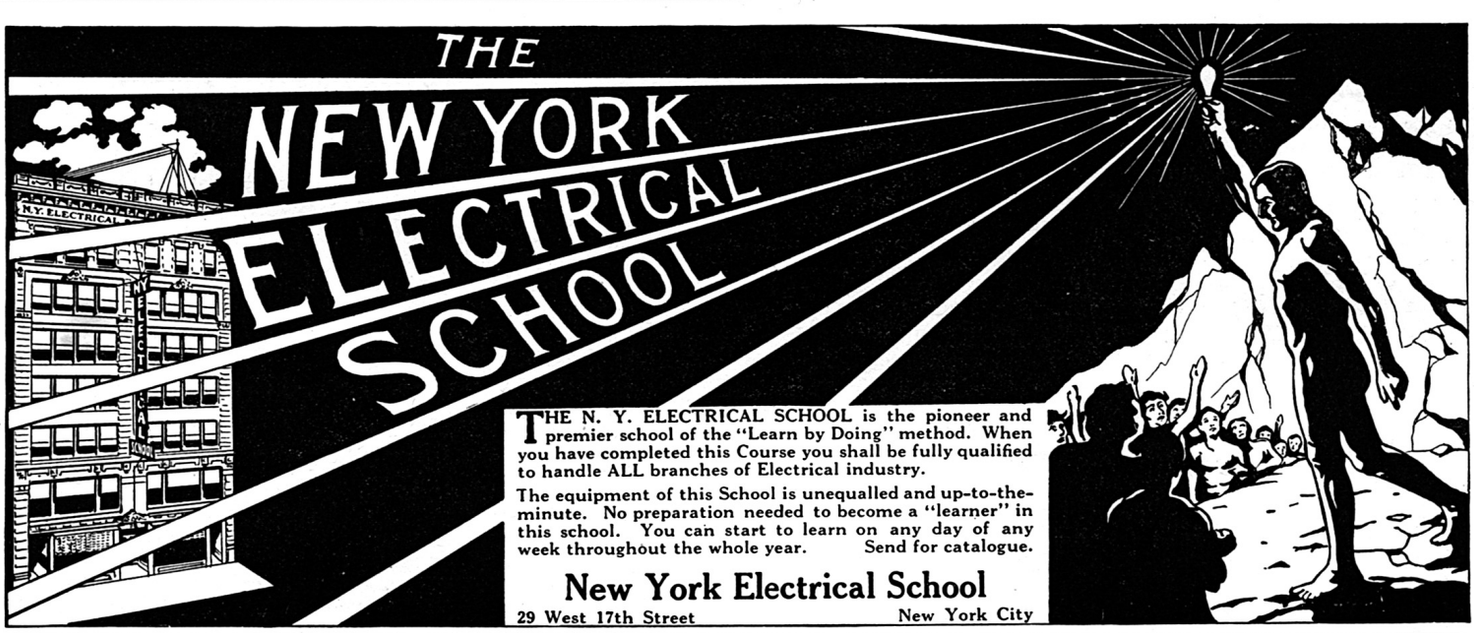

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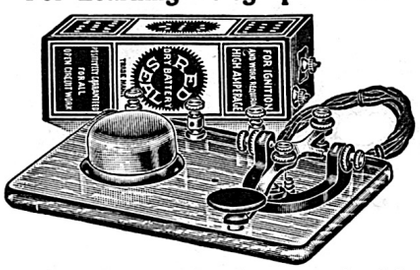

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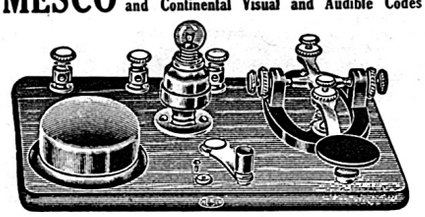

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This fact is well illustrated by the experience of the Norfolk and Western Railroad. Conjestion occurred on a particularly mountainous division of this road because, with three of the largest steam locomotives on each of the long coal trains, speeds of over 7 miles an hour could not be maintained up the steep grades. Electrification of this division was finally decided on, and now electric locomotives haul the trains up the grades at a rate of 14 miles an hour, thus *doubling the capacity* of this division.

Electric operation of the railroads would also speed up the traffic in several other ways. Better time can be made in tunnels, because there is no smoke to hamper the trains. Cold weather has no effect on electric locomotives, because there is nothing about them to freeze up. Electric locomotives are more easily handled than steam locomotives, and switching operations are more quickly performed. Furthermore, they are ready for service without previous attention; they spend less time in the round house for inspection, overhauling and repairs; and, as statistics prove, they maintain their schedules better. All of these things would assist in relieving the present situation.

What effect the reduction in the amount of coal to be hauled would have on railroad service is difficult to determine, but it seems evident that if coal were not today such an important item of freight, the railroads would be easily able to handle the necessary amounts of food, munitions, raw materials and other essential materials.

This discussion has been confined to the factors conspicuously involved in the present fuel crisis—namely, the shortage of coal and the railroad congestion—but the advantages indicated are not the only ones that would be obtained by general electrification by any means. In addition, the cost of power would be greatly reduced; power would be available to millions of people now living outside areas served by electric transmission lines; and an army of power engineers, miners and transporters and handlers of fuel, would be released for other duties. Indeed, the saving in manpower would be one of the most beneficial results.

There is nothing visionary in what has been said. The elements of a general electrification of the nation are all in our hands, and in many places, notably thru the Southern and the Pacific Coast States, the initial steps are well under way. It is the economical thing to do, and now, since the people of the United States have seen what can happen under the old system, it is certain to be done. Many readers of this article will undoubtedly live to see the plan well on the road to realization.

THE TELAUTOGRAPH—WHAT IT IS.

(*Continued from page* 823)

Gray's Telautograph.

The object of the invention by Prof. Elisha Gray, in 1893, was to overcome the difficulty heretofore experienced and provide a writing telegraph or telautograph in which the receiving pen would operate simultaneous with the transmitting pen and produce a facsimile of whatever matter was written by the operator, thereby rendering possible telautographic transmission of any kind of characters and sketches. Subsequent to this numerous patents were granted to Gray and others for minor improvements and for different forms of telautographs, but no appreciable change was made in the fundamental principles employed until about 1899.

The Modern Telautograph Principle.

About that time the Gray National Telautograph Company, from experience previously obtained and at the earnest solicitation of Mr. George Steele Tiffany, the chief experimental engineer of the Company at that time, decided to abandon entirely the old step-by-step method, which until then had been considered the only practical means of obtaining facsimle reproduction. All of the immense amount of work and mental effort of the inventors for the previous fifteen years, representing as it also did an expenditure of hundreds of thousands of dollars in development costs, was thrown into the scrap heap and Mr. Tiffany undertook to devise an entirely new form of telautograph to operate on the theory of recording varying current strengths very much like a recording voltmeter.

In this "Variable Current" instrument the motions of the transmitting pencil causes variations in strength of a continuous current, which, traversing the line wires, affects at the receiving instrument changes in strength of electro-magnets by which the pen is moved in unison with the transmitting pencil.

After several years of work the first telautograph built on this principle was completed, and while crude and cumbersome in its construction, it performed its work with a certain degree of reliabilty and satisfaction. One by one electrical and mechanical difficulties encountered in the perfecting of such an instrument have been overcome by Mr. Tiffany and others asociated with him, and the present telautograph is the practical embodiment of the many improvements devised. In this process of improving three distinct mechanical types of instruments were developed. The first type was put in use in 1901 and was later succeeded by an improved model in 1904, which in turn was superseded by the model of 1907, which in all general features is the same instrument that is in successful operation today.

Construction Problems Solved.

The greatest problem encountered in the improving and refining process of the telautograph has been to design an instrument which would be sensitive enough to respond to the smallest movement of the transmitting stylus and yet not be delicate or fragile but substantially built; an instrument that would not be deranged, but would preserve its adjustment under the most severe conditions of operation. Also, in order to make it a commercial instrument in every sense of the word, it had to be made thoroly fool-proof against careless handling on the part of the operators and against inquisitive meddling of irresponsible people.

That this problem has been solved in the present telautograph may well be indicated by the many strenuous services to which it has been put. For example, it has been mounted on the gun carriage of the heaviest type of Coast Defense gun not more than twenty inches away from the barrel and its adjustments have not been disturbed by the blast and concussion from the firing of the gun. It is also used in rolling mills of steel plants, where it is subjected to heavy and continuous vibration without experiencing any defects in service.

Telautograph Uses

The telautograph in no way replaces, nor is it a competitor of the telephone, because it is not used for communications where ordinary conversation will suffice for the transaction of business. It is only used when the message or order requires accurate or secret transmission or being in written form to prevent misunderstanding thru the deficiencies of the human element. It is more a competitor of the messenger boy with his written momorandums or the pneumatic tubes with their written messages on slips of paper.

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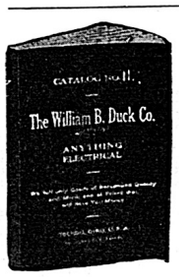

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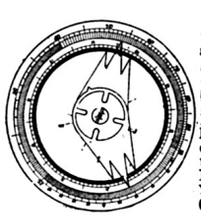

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In hotels, telautograph lines from the telephone switchboard forward guests' orders and complaints to the various hotel departments, which execute and attend to them. It is used between the telephone switchboard and front office to get information as to room numbers of the guests when they are called from outside; between telephone switchboard and bell captain for sending paging messages to locate guests when called on the telephone or called upon and the guests are not in their rooms; between telephone switchboard and service pantry, kitchen and bar for ordering meals and drinks to be served in the rooms; and for various other services far too many to be enumerated.

In department stores the telautograph is a valuable means of communication between the sales floor and reserve stock department in sending orders for replenishing stock in retail departments; for obtaining credit information between the salespeople or tube centers and the credit department when customers desire to charge goods purchased; and between the complaint and delivery departments for tracing out packages lost in delivery or sent to the wrong address.

The railroads make use of telautograph service at passenger terminals for announcing the arrivals and departures of trains, giving the time of arrival or departure and the tracks on which they will arrive or depart. These messages go simultaneously to every department that has to do with the handling of the incoming mail, express, baggage and passengers, and serve also as information to the public. For engine despatching there are telautograph lines between the engine despatcher's office and the roundhouse or engine tower for ordering and assigning engines for outgoing trains and for information as to when and on what track to report. They are further used for instructing yardmasters, station platforms, switchmen, etc., in regard to the makeup of trains.

In steel plants reports of chemical analysis of every "heat" of steel tested in the laboratory are telautographed simultaneously to the rolling mills, shears, mixers, blooming mills, billet mills and shipping department, so that the quality of each "heat" of steel is correctly known at every point where it is handled and the steel may be assigned to an order or orders for which its contents qualify it; also for recording the movements of steel billets from place to place with their distinguishing serial "heat" numbers, likewise for the purpose of identifying each lot.

In commercial, wholesale and retail houses telautographs are used for ordering articles to be brought to sales floors from stock rooms; for issuing shipping orders from order department to stock room or shipping room; for ordering goods short on incomplete orders between packing department or shipping department and stock rooms; for obtaining credit information between sales department or ordering department and credit office; and for many other uses too numerous to detail.

The foregoing are a few typical services that the telautograph renders to its users, but it by no means represents all that this wonderful instrument accomplishes in the saving of time and money or by increasing efficiency in operation of business and industrial enterprises.

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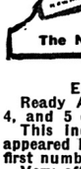

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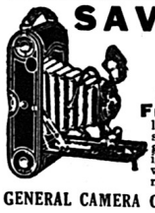

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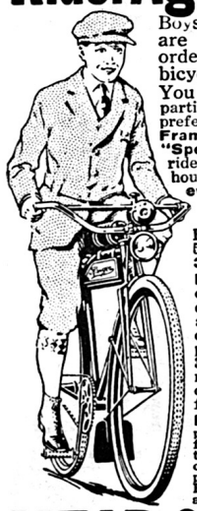

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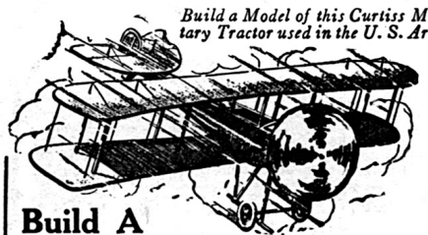

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THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(*Continued from page* 830)

metal box thru insulators and upon one a metal plate P is placed, while upon the other a very fine strip of gold leaf, hardly larger than a thread, is placed so that it hangs at an angle with the vertical. In practise the terminal A is connected to the body whose charge is to be measured, and the plate P is charged by a constant source to about 200 volts. The attraction between plate P, and the gold leaf L, holds the leaf at a certain angle which decreases, and the leaf starts to fall as soon as the charge leaks away from the body to be measured, and hence lowers the potential of the gold leaf. By using a telescope attachment to observe the leaf, an exceedingly minute loss of charge may be measured and a change in potential of even .0001 (one ten-thousandth) of a volt detected.

By such simple apparatus much has already been done. The most important qualities of the electron, namely its mass and charge, have been measured, and a careful study of different positive ions has been made in an effort to isolate the positive unit ol electricity which corresponds to the negative electron. So far no ion smaller than a molecule of hydrogen has been discovered having a positive charge of electricity, and this is of course a hundred thousand times larger than the electron.

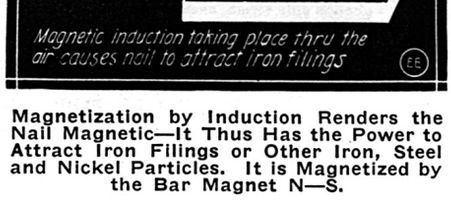
Besides these qualities of ions, four very important facts about their behavior have been studied. The velocities of different kinds of ions has been measured, and their rates of recombination and diffusion. By recombination is meant attraction and reunion of positive and negative ions to form a neutral molecule. By diffusion is meant the thinning out of the ions due to their being attracted to the walls of the containing vessel. Last, but not least, the phenomena of collision of ions has been investigated and it has been found that when ions collide with neutral molecules, fresh ions are formed. These various things represent the main phenomena which have been studied in this great field, the importance of which is just beginning to be recognized. The first question perhaps that anyone would ask is —how are the ions formed in the first place? The answer is that, according to P. J. Thomson's theory, the same thing happens in gases that happens in liquids; in other words, when a molecule falls under the influence of X-ray, heat or some other ionizing agent, the molecule is torn apart in such a way that one or more electrons fasten themselves to one part, making it negatively charged, and leaving the other part positive. These parts then are the ions, and when they travel towards any particular point, constitute a current. A charged body placed in their presence loses its charge thru having it carried away, little by little, by them. Such a slow loss of charge is the leak which an electroscope is so often used to detect.

Besides its practical importance the study of the ionization of gases should go far toward revealing what electricity and matter really are, especially as a gas is the simplest form in which matter exists.

EXPERIMENTAL PHYSICS.

(*Continued from page* 834)

found to no longer hang horizontally (except at the equator), but one end *will dip* (the N pole in northern latitudes and the S pole in southern latitudes), the amount of dip, technically called *inclination,* being equal to the latitude. Thus the dip needle can be used to determine latitude (approximately). The miner uses it to determine the presence of magnetic ores. At most places on the earth the magnetic needle does not point true north, but instead a

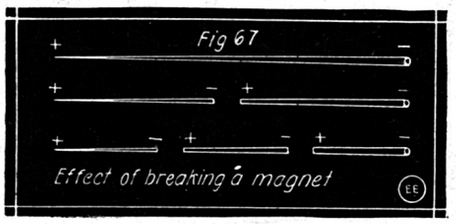


Magnetization by Induction Renders the Nail Magnetic—It Thus Has the Power to Attract Iron Filings or Other Iron, Steel and Nickel Particles. It is Magnetized by the Bar Magnet N—S.

little to the east or west of north. Hence, if we wish to know direction accurately, we must add the correction (called declination) to allow for this, i. e., the *declination* is the *difference in direction between true north and the direction in which the magnetic compass points.* Since the declination varies for different places from year to year, the variations are recorded, so that when surveys are made the true north-south direction can be determined and the land mapt accurately.

EXPERIMENT 70—Place a tack against a magnet and now bring this tack near another tack. The first tack will act as a magnet. Thus we see that when a piece of iron is put in contact with a magnet, it becomes *a magnet itself* and will attract iron. The reason why, then, that a magnet, when dipt into iron filings or nails, lifts a number of them attached to one another is that each becomes a distinct magnet. This influence of a magnet over iron or steel by which it is made a magnet extends

to a considerable distance from the magnet and is called *magnetic induction*. That magnetic induction takes place even tho the iron does not touch the magnet, which is shown as follows: Place a bar magnet upon a table and at one end, in line with and about an inch away, put a large iron nail. Bring some iron filings near the end



Did You Ever Break a Steel Magnet? If You Have, Then Upon Testing Each New Piece Formed, With a Compass Needle, You Have Learned that Each Piece Has a North and South Pole, as This Sketch Shows.

of the large nail furthest away from the magnet and observe that it attracts the filings. If you test this end of the nail with a compass you will find that its polarity is *opposite* to that of the magnet pole nearest it. (See Fig. 66.) It is because of this property of induction that magnets attract iron. When the iron is brought near the magnet, the nearer end becomes *polarized oppositely* to the pole of the magnet, and then, because of the force of attraction between unlike poles, the iron is attracted.

EXPERIMENT 71—Magnetize a needle. Determine its polarity. File a notch at the middle and break it. Examine for polarity again and compare with the polarity of the needle before breaking. Break one of these pieces in the middle and proceed as before. It will be found that each piece in turn becomes a true magnet with poles, as in Fig. 67. Thus every new magnet has a N and a S pole.

EXPERIMENT 72—If a needle is magnetized and then heated to redness by being held in the flame of a Bunsen burner, it will be found, on testing after cooling, that it has lost its magnetism. Try to pick up a red hot piece of steel with a magnet. It will be found that the red hot piece of steel is *non-magnetic*, i. e., induction can not take place and the magnet will not pick it up.

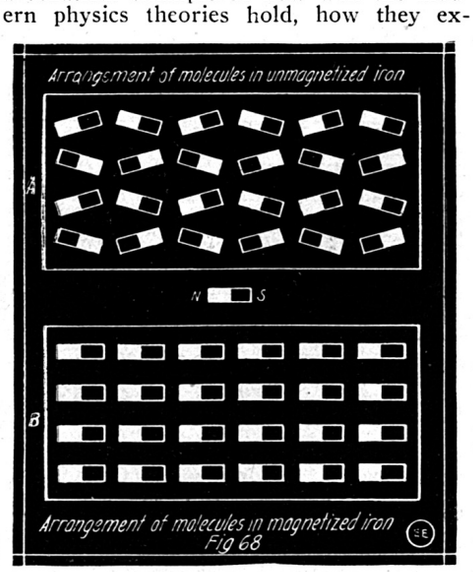
EXPERIMENT 73—The fact that a freely swinging magnet assumes a north-south position shows us that the earth acts as a gigantic natural magnet, with a — pole at the north and a + pole at the south. Naturally one would expect that the earth should have an inductive action, and this can be verified as follows: Select a soft iron rod about a half inch in diameter and about two feet long. Holding it horizontally in an east-west line, present its ends successively to the N and S ends of a compass. Both ends will attract each end of the needle, showing that the bar is not polarized. Next hold the bar in a north-south line and dip it an amount equal to the *inclination*. On bringing the compass near we notice repulsion at one end and attraction at the other end, showing that the bar is now magnetized. Bring the bar again into the first horizontal positon and again it will attract both ends of the needle, showing that it is unpolarized. Place the bar again at the dip angle and in north-south position and give it a few sharp blows with a hammer. Now place it in the first horizontal position, and on testing we find the bar polarized. Now hold the bar horizontal in east-west position and give it a few sharp blows and it will be found to have lost its polarity. This is a conclusive proof of the inductive action of the earth and also furnishes us with phenomena to be considered in formulating a theory of magnetism.

Molecular Theory of Magnetism.

These last few experiments are very important, in so far as they substantiate our theory. In accordance with the molecular theory of matter we assume that a magnet consists of very many minute elementary magnets, arranged as in Fig. 68-B, and an ordinary piece of soft iron also consists of small elementary magnets, but arranged as in Fig. 68-A, i. e., when iron is *unmagnetized* its molecules are arranged helter-skelter, whereas when *magnetized* they are all lined up with their respective + ends in one direction, so that they act as one large north pole, and likewise for the — poles. Obviously, if we break a magnet in half, each piece will be a magnet, and this might be kept up until the original magnet is broken up into its small elementary magnets. This agrees with our theory. If we heat a magnet (since heat causes the molecules to move more rapidly) the magnetism is lost, because the elementary magnets are disarranged from their straight line position of Fig. 68-B to the position of Fig. 68-A.

Induction occurs in accordance with our theory; also when the + end of a magnet is brought near a piece of iron all the — ends of the elemental magnets are attracted to it, acording to the law of attraction, and hence these small magnets line up as in Fig. 68-B. In experiment 73, on striking the iron bar, the tiny molecular magnets were jarred, and hence lined up, due to the earth's induction when placed in a north-south line, while when in the east-west position they were jarred out of the north-south line. As a final conclusive proof of the exactness of the molecular theory, stroke a needle once with a magnet; bring the needle up to a compass and note the deflection; stroke once more and note the increased deflection. After stroking several times it will be found that the point is reached when further stroking no longer increased the deflection, i. e., the needle has reached its point of magnetic saturation. Since the point will be reached when all the little elemental magnets are lined up, no further stroking will cause any change, hence no increase in strength.

The molecular theory of magnetism is a beautiful example of how well the modern physics theories hold, how they explain phenomena, and how they are themselves strengthened by these phenomena. It is because of this that we adhere to them with so much faith and swear by them. Most of them are so well establisht that we vouch for them as we would for facts.



Schematic Illustration of Arrangement of Iron Molecules Before and After Magnetization. Each Molecule Becomes an Elemental Magnet in Itself.

(To be continued.)

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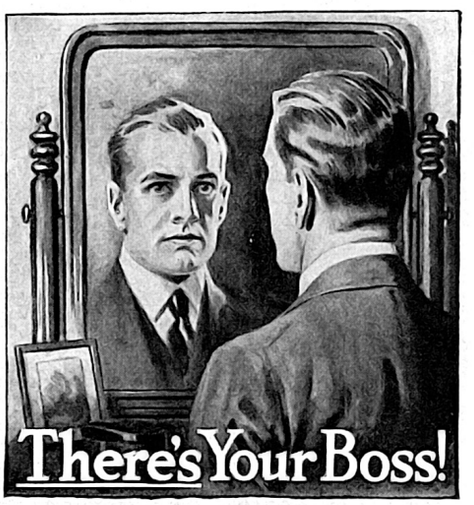

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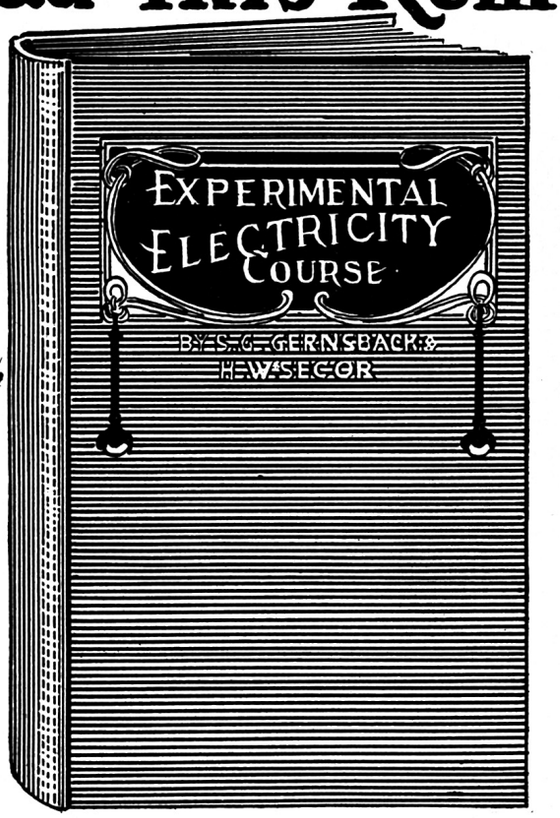

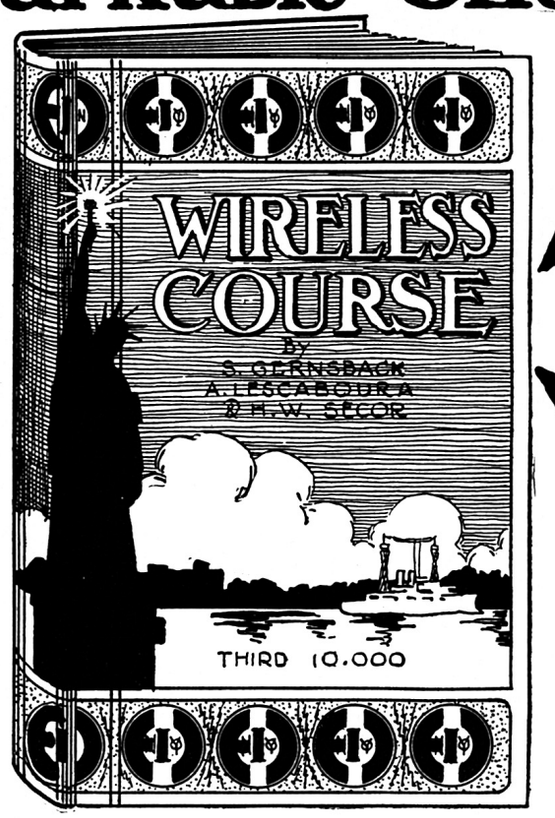

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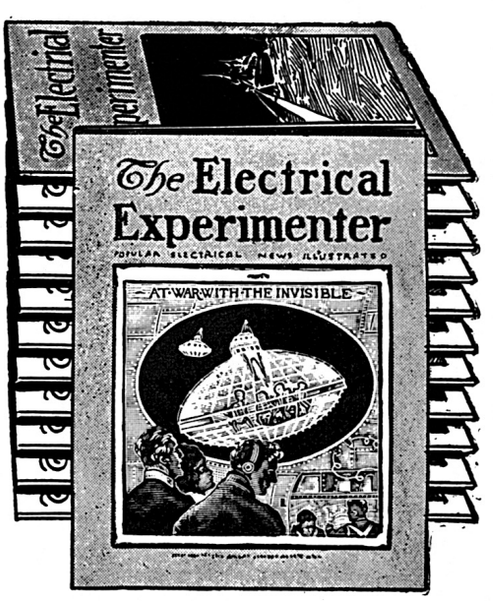

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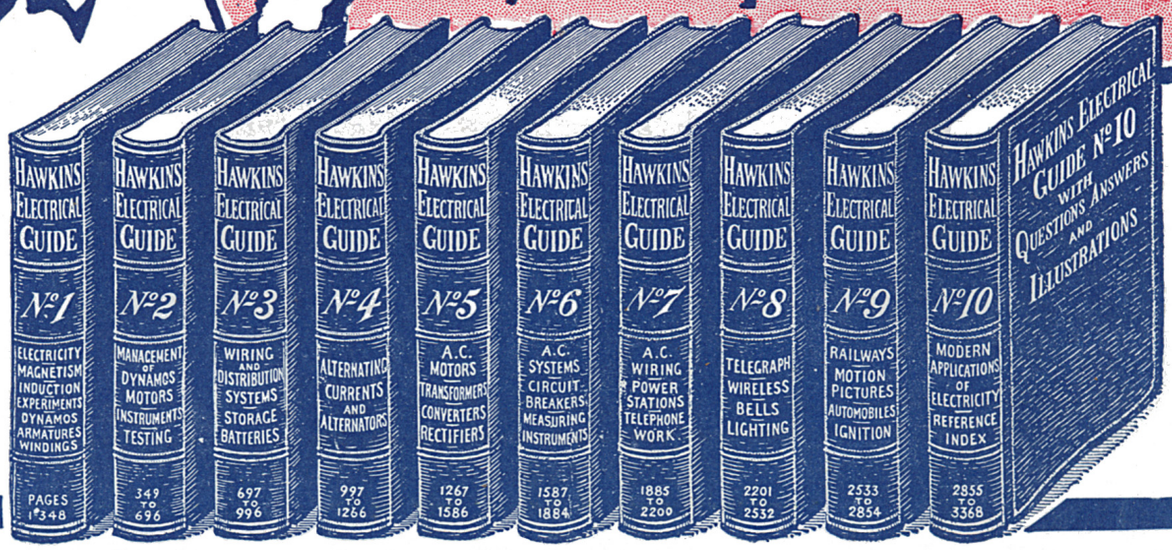
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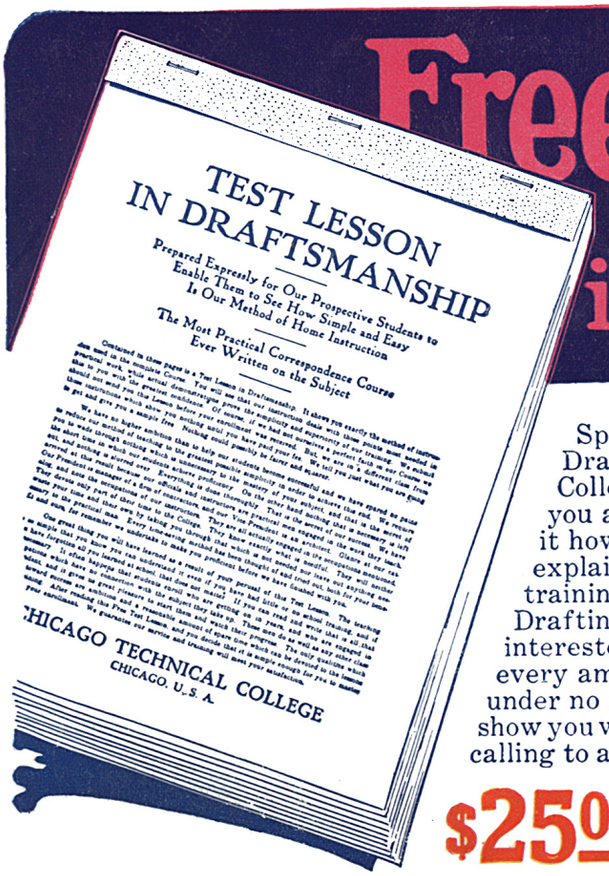
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